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MEMORANDUM
May 5, 1982

To: Carl Nuechterlein

From: Lynn Singleton LS and Joe Joy JJ

Subject: Mill Creek Receiving Water Survey

Introduction

A receiving water survey was conducted February 3 and 4, 1981 on Mill Creek, Walla Walla County, by Lynn Singleton and Joe Joy, Water Quality Investigations Section, Washington State Department of Ecology (WDOE). A Class II inspection of the Walla Walla Sewage Treatment Plant (STP) was conducted concurrently and is covered in a separate memorandum (Yake, 1981). The primary purpose of the receiving water survey was to evaluate the STP discharge impact upon Mill Creek during winter low-flow conditions and determine the sources of any other inputs which may affect water quality. Information gained during this survey is analyzed to estimate water quality conditions under different stream flows and effluent qualities. These findings will provide information to aid in the development of the forthcoming updated NPDES permit. As you are aware, the plant is currently operating under an expired permit.

Background

Mill Creek flows from the western slopes of the Blue Mountains, through the City of Walla Walla, and empties into the Walla Walla River five miles downstream of the city. Between river mile (r.m.) 4.5 and 11.5, the creek bank and bed have been channelized and groined to various degrees by the Army Corps of Engineers (A.C.E.) for flood control. Those modified portions of the stream not having a concrete bottom are usually covered with gravel and rubble. The seven-mile channelized reach begins upstream of the city and terminates on the western edge of the residential district.

The Mill Creek waters are heavily used for potable water supply and irrigation supply. The City of Walla Walla municipal water intake is located at r.m. 25.2. The intake includes a dam and impoundment. The greatest irrigation demand occurs in spring, summer, and early fall when the entire flow of Mill Creek may be diverted to Yellowhawk and Garrison creeks via a diversion dam at r.m. 10.5 (Figure 1). Flows downstream of the diversion may be less than 1 cfs. They are maintained by groundwater intrusion, incidental leakage, and irrigation return. Minor point source inputs may also contribute to flows during this period. Diversion of Mill Creek generally begins in May and terminates around December (Hansen, 1981). A division dam is located just upstream of this diversion, and is used for flood control.

The Walla Walla STP has the only NPDES permit currently in force on Mill Creek. The STP discharges to Mill Creek from about October 15 to April 15. The water district has the water rights on the STP effluent. They can divert the entire effluent from the creek to the irrigation district channels if it is needed, but are under no obligation to do so (Peterson, 1981). Water which is not used by irrigators is wasted back into Mill Creek at three different locations. The discharge points are located: (1) just upstream of the STP outfall; (2) above Case Street; and (3) below Case Street. Other tailwaters are also discharged to Doan and Cold creeks (Prouty, 1981). Cold Creek enters Mill Creek at r.m. 1.7 and Doan Creek enters at r.m. 0.3.

Fishery

Mill Creek maintains a sport fishery with native populations of steelhead and rainbow trout. Rainbow and steelhead eggs and fry, and Dolly Vardon fry have been stocked in the stream during the recent past by the Washington State Department of Game (WDG); however, a regular stocking program is not in practice.

Migrating adult salmonids are occasionally blocked by the A.C.E. dams. When this occurs, WDG personnel net the fish and release them upstream (Vail, 1981). The A.C.E. has received funding to construct fish ladders to improve passage and alleviate the need for netting. Construction should be completed by 1983.

The State of Washington has adopted the national goal of making all waters fishable, swimmable by 1983. This responsibility includes maintenance of minimum flows during key periods of the year so that adequate water and water quality exists to allow fish passage in Mill Creek. Migrating adults are probably in the Walla Walla River in September; however, they have to wait until adequate water is present in Mill Creek before entering. Migration up the creek generally occurs from December through May. Spawning is confined to the drainage above the dams. Juveniles usually remain in the creek for one year and migrate downstream from January through May.

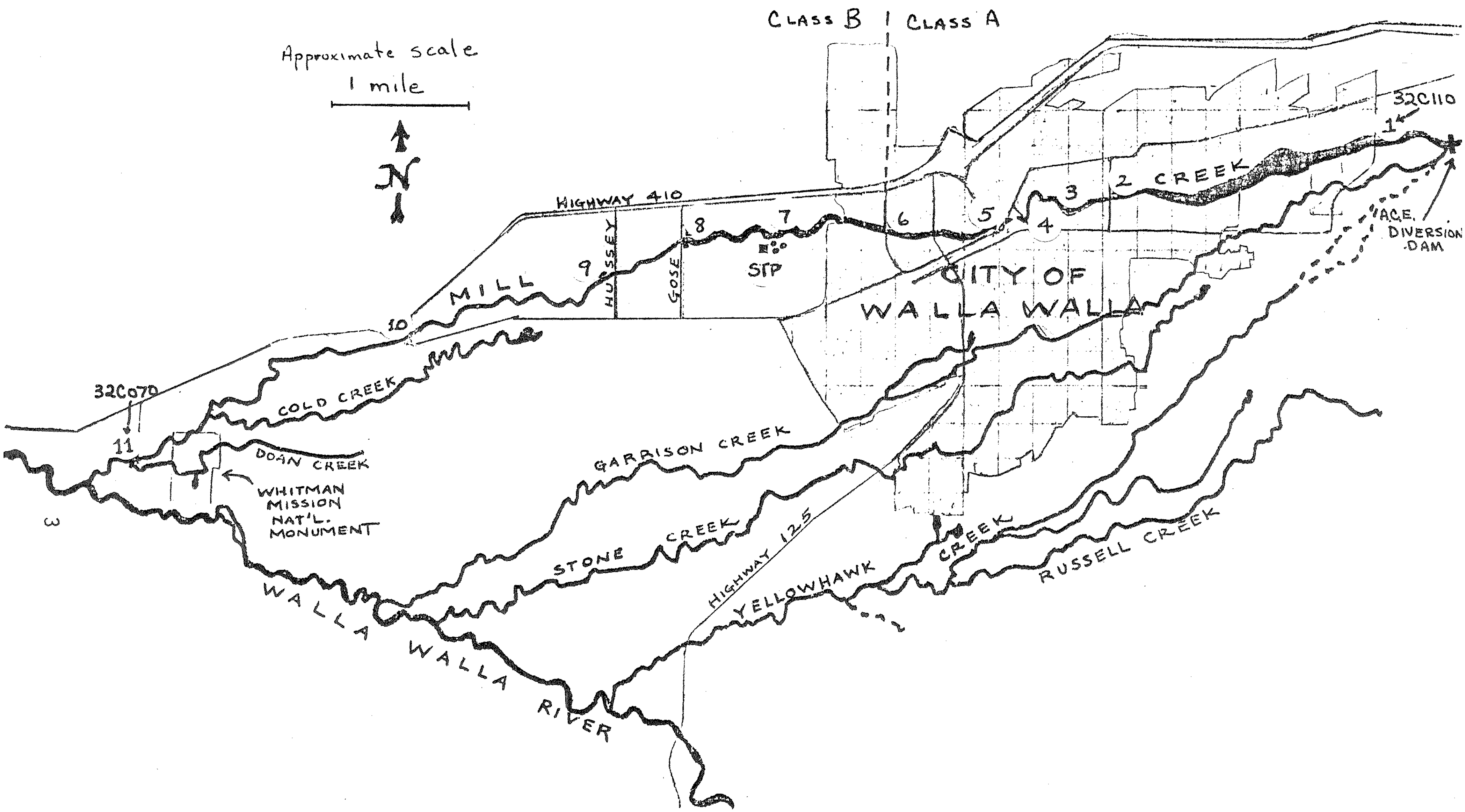

Figure 1. Map of the study area, Walla Walla, Washington.

	J	F	M	A	M	J	J	A	S	O	N	D
Juvenile Residence	—	—	—	—	—	—	—	—	—	—	—	—
Juvenile Migration	—	—	—	—	—							
Adult Migr. & Spawn	—	—	—	—	—							—
STP Eff. Discharged	—	—	—	—						—	—	—
STP Eff. Diverted					—	—	—	—	—	—	—	

The fishery appears to be maintained during summer low flows in the waters upstream of the diversion dam and in Yellowhawk and Garrison creeks. Those fish which survive in Mill Creek below the dam, do so because of groundwater input. Fishkills have been reported during the summer low-flow periods below the dams (Vail, 1981). However, the extent, dates, and causes of the fishkills apparently have not been documented.

Water Classification

Mill Creek waters have been placed in three classifications. Mill Creek from the confluence of the Walla Walla River to the 13th Street bridge (r.m. 6.3) is designated Class B; the waters from 13th Street to the City of Walla Walla waterworks dam (r.m. 25.2) are Class A; and all waters upstream are Class AA. The Class B designation has a special proviso stating that a concentration of 5.0 mg/L dissolved oxygen (D.O.) or 50 percent saturation will be maintained (WDOE, 1977). This study involves only the Class A and B waters. Definitions of the specific classifications may be found in Appendix I.

Historical Data

Flows

Table 1 gives the monthly mean flows and exceedence probabilities determined from USGS discharge records (1966-1980) at station 14015002 (WDOE station 32C110). These data illustrate the discharge norms for the creek. It is important to note that discharge from June through November changes little as recurrence frequency increases. The 1-in-10-, 1-in-5-, or the 1-in-2-year low flows for these months are very similar.

Discharge measurements were also made at USGS station 14015400 (WDOE station 32C070) for a short period of time. These data may be found in Appendix II.

Table 1. Monthly low flow recurrence interval for USGS station 14015002 covering 1966 to 1980 discharge records.

Month	Stream flow (cfs) Recurrence Interval - low monthly flow			
	2 year	5 year	10 year	20 year
January	185.0	90.3	57.7	38.3
February	170.8	85.9	49.4	28.0
March	163.4	98.4	72.4	55.0
April	144.3	78.5	55.1	40.4
May	71.5	14.7	4.9	1.7
June	10.4	1.9	0.7	0.3
July	1.5	0.4	0.2	0.1
August	1.3	0.6	0.4	0.2
September	0.7	0.2	0.1	0.0
October	1.1	0.2	0.1	0.0
November	11.7	2.4	1.0	0.5
December	86.8	33.3	19.1	11.7

Water Quality

Water quality data have been collected by WDOE from two sites on Mill Creek from 1972 to 1975. Station 32C070 is located at r.m. 0.4 and station 32C110 is located at r.m. 10.0. Appendix II contains the available WDOE records. The waters below the 13th Street bridge, represented by 32C070, have been in violation of Class B standards for pH, dissolved oxygen, temperature, and fecal coliform bacteria. Un-ionized ammonia concentrations were calculated during the Water Quality Index (WQI) analysis (Singleton and Joy, 1981) and found to be greater than the 0.016 mg/L criteria (USEPA, 1976) in five percent of the samples taken at 32C070 (unpublished data). The upstream Class A waters, represented by station 32C110, had temperature, pH, and fecal coliform standards violations. Nutrients were in excess at both stations. This analysis indicates Mill Creek had the seventh worst WQI, 46.1, in the state. Clearly, Mill Creek has experienced water quality violations in the recent past. Land use and wastewater discharge practices have not changed appreciably since the last routine WDOE monitoring occurred in 1975 (Farrell, 1981). This suggests that the problems are still present.

Methods

Water quality samples were taken at 11 stations within the study area, beginning with 1 at r.m. 10.0 and ending with 11 at r.m. 0.4 (Figure 1).

Grab samples were taken at seven sites above the outfall (stations 1 through 7) and four sites below the outfall (stations 8 through 11). In addition, 24-hour composite samples were taken at stations 1 and 9 with Manning field compositors set to collect 250 mls every 30 minutes.

Field analyses of the following parameters were performed at each station: temperature (°C); dissolved oxygen using the Winkler method; total residual chlorine (TRC) using DPD ferrous titrametric method; specific conductivity and pH by field meters. In addition, water quality samples were collected, packed in ice, and transported to arrive at the Tumwater WDOE analytical laboratory within 24 hours. Selected combinations of the following analyses were performed on those samples:

pH (S.U.)
Specific Conductivity (μmhos/cm)
Chemical Oxygen Demand (mg/L)
Biochemical Oxygen Demand 5, 12, 15, 20 (mg/L)
Nitrate-N (mg/L)
Nitrite-N (mg/L)
Ammonia-N (mg/L)
Orthophosphate-P (mg/L)
Total Phosphate-P (mg/L)
Chloride (mg/L)

Total Solids (mg/L)
Total Non-volatile Solids (mg/L)
Total Suspended Solids (mg/L)
Total Non-volatile Susp. Solids (mg/L)
Turbidity (NTU)
Fecal Coliform (org/100 ml)
Total Copper (mg/L)
Total Zinc (mg/L)
Total Iron (mg/L)
Dissolved Nickel (mg/L)
Dissolved Chromium (mg/L)
Dissolved Cadmium (mg/L)
Dissolved Lead (mg/L)
Dissolved Manganese (mg/L)

All laboratory analyses were performed according to procedures stated in *Methods for Chemical Analysis of Water and Wastes* (USEPA, 1979). Un-ionized ammonia fractions of total ammonia were calculated using field temperature and pH values (Thurston, Russo, and Emerson, 1979).

Stream discharge was determined at stations 8, 9, and 11. A Marsh-McBernie Magnetic Flow Meter and stream dimension measurements of two to four feet were used for each cross-section.

Discharge for station 1 was obtained from the Army Corps of Engineers' gaging station located at r.m. 10.5. Measurement of flow was attempted at station 7; however, the series of closely spaced, broad, gravel, weir-like structures and undercut banks in the area made the estimates inaccurate. Flows at this site were estimated from the mean of the discharge at stations 8 and 9 less the estimated STP discharge. The STP discharge was estimated by comparing plant flows given by Yake (1981) with the results of a mass balance using station 9 as the complete mix area. For the purpose of our calculations, the discharge from the STP was taken to be 10.2 cfs.

Results and Discussion

Upstream of Walla Walla STP

Survey results are given in Table 2. Seven stations and two point sources are included. Station 1 indicated the upstream condition for this waterway. All constituents monitored were within Class A water quality standards. The BOD_5 of 1.2 and 1.7 mg/L is somewhat high for an undisturbed creek (Velz, 1970); however, the basin upstream of station 1 is not a remote area and is undoubtedly impacted by mans' activities. The dissolved oxygen was at 88 percent saturation. Below station 1, the creek enters its groined concrete channel. The data indicate that the turbulence caused by the groins effectively raised the concentration of dissolved oxygen.

Water quality remained relatively constant between stations 1 and 7. Nitrate-N increased slightly as the creek passed through Walla Walla. This increase may have been due to groundwater recharge in areas not covered by concrete or from groundwater infiltration of the many stormwater discharge pipes entering the creek (Farrell, 1981). Additional point sources also may have been present and partially responsible for the increases; however, this was not verified. The flows at stations 1 and 7 are quite similar and therefore do not reflect any change in stream flow. However, withdrawal was occurring during the survey. One large pipe (18 to 24 inch diameter) was found withdrawing water from Mill Creek and there was a likelihood of others as well. Water withdrawal and selective discharge practices present in Mill Creek make a mass balance calculation of the system above the STP impossible within the scope of this survey.

Two previously unknown point sources (Peterson, 1981) with relatively small discharges were found during the survey. The first was located at about r.m. 8.2 and appeared to be cooling water from Whitman College. This source was warm, contained few nutrients, and had a higher dissolved ion concentration than the creek. The second point source was located on the downstream side of the 13th Avenue bridge (station 6). It appeared to originate from the Jones-Scott Company, a sand and gravel operation. This discharge was highly turbid and contained large amounts of solids and oil, probably from the trucks and machinery located at the site. Nutrients were higher than in-stream levels. The impact of the first point source was negligible during the survey; however it may impact the creek's temperature during the very low-flow conditions in the summer. The second point source aesthetically impacted the creek in the area immediately downstream; however no deleterious effects were observed at station 7 (0.9 mile downstream). The impacts may be greater if this source discharges during the summer low-flow period.

Walla Walla STP and Downstream

The Walla Walla STP outfall discharges to Mill Creek at r.m. 5.4. At a plant flow of 10.2 cfs, the stream/effluent dilution ratio was 5:1, much lower than the 20:1 ratio recommended in the dilution zone guidelines (WDOE, 1980). A minimum flow of 204 cfs would have been required to meet the guidelines. Under present conditions, this could be difficult to obtain in some years. During the period when the STP is permitted to discharge directly to Mill Creek, mid October to mid April according to the expired permit, the guideline is rarely met. During the water years 1973-1980 (USGS, 1972; 1973; 1974; 1975; 1976; 1977; 1978; 1979; and 1980) only 16 percent of the months in the October-April period had a mean discharge greater than 200 cfs. Many times in October and November the discharge was below 10 cfs (see Table 1). This, at best, is a dilution ratio of 1:1. The expired NPDES permit states that a minimum flow requirement of 25 cfs (as measured below the plant) is required for discharge. This represents a dilution ratio of only 1.5:1. A 1-in-2-year October flow of 1.1 cfs indicates this guideline is rarely met if STP discharge occurs in October.

Mass balance calculations indicated that mixing of the STP effluent was complete at station 9. The plant's impact upon the in-stream concentrations of BOD, COD, nutrients, solids, chloride, and conductivity below the plant was very apparent. The dissolved oxygen concentration and percent saturation began to decline below the plant as the carbonaceous and nitrogeneous oxygen demand were exerted. This process will be discussed in greater detail later in the text. The ammonia concentration decreased steadily as distance from the plant increased. Nitrification through the actions of the nitrifying bacteria *Nitrosomonas* and *Nitrobacter* probably influenced this decrease according to the following reactions:

$$NH_4^+ + 11/2\ O_2 \xrightleftharpoons{Nitrosomonas} 2H^+ + NO_2^- + H_2O$$

$$NO_2^- + 1\text{-}1/2\ O_2 \xrightleftharpoons{Nitrobacter} NO_3^-$$

The nitrification process consumes dissolved oxygen and releases hydrogen ions (Hines *et al.*, 1977). Each station below the outfall showed progressive increases in nitrate-N and declines in ammonium-N; however, the decrease in pH was not observed. Un-ionized ammonia levels were calculated (Table 2) and found to be below levels harmful to aquatic life (USEPA, 1976).

The effluent concentration of total residual chlorine (TRC) allowed in the proposed NPDES permit is 0.5 mg/L. The STP effluent was analyzed at three different times and found to contain 0.45, 0.45 (Yake, 1981) and 0.37 mg/L TRC. The mean, 0.42 mg/L, had a theoretical complete mix in-stream concentration of 0.06 mg/L. TRC at station 8, taken 0.6 mile downstream of the outfall, was 0.05 mg/L. No TRC was detected 1.05 miles downstream (station 9). A concentration of 0.06 mg/L is 30 times greater than the level (0.002 mg/L) required to protect salmonids (USEPA, 1976). Chlorine toxicity is a problem that deserves consideration. Had the dilution zone guidelines of 20:1 been met, the theoretical complete mix would have been 0.021 mg/L TRC and the impacted area considerably less than what was observed. Avoiding chlorine toxicity in Mill Creek may require dechlorination at the STP.

The data indicate additional polluting source(s) may exist between station 9 and station 10. Conductivity, chloride, and nitrate-N all increased at station 10. Similar increases were observed between station 10 and 11. Cold Creek enters Mill Creek between stations 10 and 11 and is the likely source of the increase. It is, however, difficult to determine whether Cold Creek is solely responsible for the increases or not, as the Mill Creek bank was not walked. The increases in nitrate-N were greater than what would be expected from the nitrification of ammonia.

Dissolved Oxygen Model

During this survey, dissolved oxygen (D.O.) depletion was observed downstream of the STP. Although the loss was small, field measurements and sample results gave some indication of D.O. sag which may occur from wastes introduced by the STP.

Carbonaceous and nitrogeneous wastes exert a certain amount of oxygen depletion when introduced into a stream. These are the carbonaceous biochemical oxygen demand (CBOD) and nitrogeneous oxygen demand (NOD), as mentioned earlier. The stream's ability to assimilate these demands is dependent on certain physical characteristics of the water and stream channel. Also important are the NOD and CBOD loads occurring: upstream of; from; and after the point source.

In order to assess the capacity of Mill Creek to assimilate these oxygen demands under a variety of flow and loading regimen and still maintain the 5.0 mg/L D.O. content or 50 percent saturation, a mathematical stream model was utilized. The model that was chosen to depict the changes in D.O. in Mill Creek is a relatively simple one. Taken into account were: the reaeration rate (K_2);

CBOD decay rate (K_1); NOD decay rate (K_3); temperature compensations for K_1 and K_2; and changes in velocity, channel depth and width under four discharges. Not taken into account were: effects of photosynthesis and respiration; benthic oxygen demand; influences of Cold Creek or changes in the STP outfall location when tailwater wastage back to Mill Creek occurs; temperature compensation for the NOD (K_3); and the reaeration effect of the series of groins between the outfall and station 9.

The central equation for the model was based upon equations in the literature (Hammer and MacKichan, 1980; Yake, 1981b), and was as follows:

$$D = C_o - \frac{K_1 L_o}{K_2 - K_1} \exp(-K_1 t)\exp(-K_2 t) + \frac{K_3 N_o}{K_2 - K_3} \exp(-K_n t) - \exp(-K_2 t) + D_o \exp(-K_2 t)$$

where D = predicted oxygen concentration
C_o = dissolved oxygen concentration after complete mix
L_o = ultimate CBOD (mg/L)
N_o = ultimate NOD (mg/L)
D_o = $P - C_o$
t = time (days)
K_1 = CBOD decay rate, base e (day^{-1})
K_2 = reaeration rate, base e (day^{-1})
K_3 = NOD decay rate, base e (day^{-1})
exp = log base e
P = dissolved oxygen at 100 percent saturation

Rates for CBOD, K_1, and NOD, K_3, were calculated from BOD and ammonia concentrations found during the receiving water study. The K_1 rate was the slope of the line determined graphically by plotting time versus $[time/BOD]^{.33}$, the BODs being those of the nitrification inhibited STP effluent. The NOD rate, K_3, was determined by calculating the theoretical conversion rate of ammonia nitrogen to nitrate nitrogen downstream of the STP. This was accomplished by plotting ammonia concentration versus time of passage in days, downstream of the STP. Stream temperature and winter-season conditions eliminated the need for a photosynthetic rate correction factor on the NOD rate. During other seasons, this correction factor would need to be found. Both K_1 and K_3 were then converted into Naperian, log base e, rates for their use in the central equation.

The ultimate CBOD (L_o) and ultimate NOD (N_o) are the potential levels of carbonaceous and nitrogeneous oxygen-demanding material to be assimilated by the stream. The ultimate CBOD was calculated from the theoretical complete mixing concentration of CBOD based on the STP effluent and station 7, upstream of the STP. These two values were back-calculated from the K_1 rates found for the STP effluent and station 7. The ultimate NOD is the theoretical complete mixing concentration of ammonia downstream of the STP multiplied by 4.3 mg/L O_2, the quantity of oxygen used in the ammonia to nitrate conversion. Stoichiometrically, the conversion requires 4.57 mg of oxygen for each mg of ammonia; however, conversions using bacteria cultures have utilized only 4.3 mg of oxygen (Hammer and MacKichan, 1980).

The reaeration rate, K_2, is the stream's ability to oxygenate itself through physical means. It is ultimately dependent on channel configuration, bed slope, bed material, and depth of the stream. During the winter months, it is the primary source of oxygen entering the stream, while in other months photosynthesis may become so. The reaeration rate was calculated from a formula and using current data collected in the field and unpublished data from USGS (Table 3). It was necessary to estimate velocity (V) as it relates to discharge (Q). A linear regression of discharge versus velocity ($V = 0.01\ Q + .96$, $r^2 = .83$) was used to satisfy this need. The reaeration rate formula is as follows (Hammer and McKichan, 1980):

$$K_2 = 2.2 \times [v/(H \exp(1.33))]$$

where K_2 is the reaeration rate, per day
and v = mean velocity, meters per second
and H = mean depth of flows, meters

The rates for demand and reaeration are temperature-mediated. Rate formulas are designed for 20°C and temperature compensation formulas are used to adjust for field or seasonal differences in temperature. The formulas for temperature compensation used were:

$$K_{1,t} = K_{1,20}\ (1.047)^{(T-20)}$$

$$K_{2,T} = K_{2,20}\ (1.022)^{(T-20)}$$

where $K_{1,20}$ and $K_{2,20}$ are the CBOD and reaeration rates found earlier. And $K_{1,T}$ and $K_{2,T}$ are the desired rates at the desired temperature.

Table 3. USGS unpublished data for station 14015400 (WDOE station 32C070).

Date	Velocity (ft/second)	Discharge (cfs)
09/25/73	0.6	5.9
11/21/73	3.6	179
01/11/74	3.2	117
03/01/74	3.7	203
04/24/74	4.1	3.5
06/20/74	2.8	123
08/13/74	0.6	2.6
10/03/74	0.5	3.4
11/22/74	1.4	37.5
01/16/75	5.3	499
03/14/75	3.2	150
05/15/75	3.4	344
06/09/75	0.4	7.8
07/11/75	0.9	26.1
09/03/75	0.4	5.3

Finally, the time of passage, t, is calculated using the channel volume method (Velz, 1970). The value expresses the time taken in days for an entire given volume of water to move past a point downstream. The formula uses mean depth, width, and discharge for the length of stream from the STP outfall to stations 8 through 11, considered to be a hydrologically uniform reach of water. The formula is as follows:

$$\frac{\text{length (ft)} \times \text{width (ft)} \times \text{depth (ft)}}{\text{discharge (ft}^3\text{/sec)}} = \text{time (sec)}$$

The time, t, in seconds is then converted into days and used in the central dissolved oxygen model equation.

The computer model (Appendix III) has definite limitations; however, if its use is confined to somewhat similar conditions, it can provide an estimate of the dissolved oxygen system in Mill Creek. These estimations are useful for planning and help explain some of the past observations made on Mill Creek. Additional field and laboratory observations would be necessary to further evaluate the influences of such seasonal and daily factors as: the photosynthetic rate; impact of the groins during low-flow conditions; transferring the waste discharge to another point farther downstream; and the diel oxygen pattern.

Model Input Assumptions

Nine input values are required by the first version of the model, Mill 1. They are as follows: (1) STP discharge; (2) upstream temperature; (3) STP effluent temperature; (4) upstream dissolved oxygen concentration; (5) STP effluent D.O.; (6) upstream NH_3-N; (7) effluent NH_3-N; (8) upstream BOD; and (9) effluent BOD. All of the above parameters are held constant within a given output. All input data were obtained from the field work for the initial model calibration.

The upstream flow in Mill Creek is set at four different levels in the output presented in Appendix IV. A zero upstream flow is used to represent the condition which could occur under the proposed NPDES permit. The draft permit will not have a minimum creek flow requirement before the Walla Walla STP can discharge to the creek (Peterson, 1981). This situation would occur if water was completely diverted upstream and the STP began to discharge, or diversion occurred while the STP was already discharging. A zero upstream discharge produces an anaerobic condition in the stream. It should be noted that when there is no D.O. present in the stream, the demand cannot be exerted and is delayed. If this condition were present, a greater downstream area would be affected than the model indicates. The model does not adequately account for demand once the stream becomes anaerobic.

The second flow represents the conditions specified in the expired NPDES permit where a minimum downstream flow of 25 cfs must be present while discharging. The purpose for the 25 cfs downstream flow was to prevent toxic conditions resulting from the STP effluent. The mean low flow of 1.1 and 11.7 cfs for the 1-in-2-year monthly flow for October and November, respectively, indicates that the 25 cfs stipulation may not have been observed if discharge occurred in either month. The model indicated in-stream levels of D.O. are above the criterion for the discharge and physical conditions present during the February survey; however, the same discharge quality and quantity may cause in-stream D.O. problems during warmer weather.

The third flow was observed during the field survey. This output corresponds to field data and is the measure of the model's ability to reproduce natural conditions.

The fourth flow represents the quantity of upstream discharge required to maintain the 20:1 ratio for the dilution zone guidelines.

Cause of D.O. Depression in Mill Creek

Four factors in the STP effluent can affect the downstream D.O. level: (1) D.O. concentration; (2) temperature; (3) BOD_5 concentration; and (4) NH_3-N concentration. Each factor was analyzed for its individual impact in terms of the compensating stream flow required.

1. The D.O. concentration of the effluent is important because the stream D.O. will drop if effluent water of a lower D.O. is mixed with it. The January, 1980 to November, 1981 DMRs indicate the mean effluent D.O. for the period was 7.7 mg/L. If this concentration is used with an STP discharge of 10.2 cfs, a 1 mg/L increase in effluent D.O. concentration would reduce the amount of stream water needed by 1 cfs. The effluent D.O. concentration adjustment appears to be a minor point, but may become a viable alternative if the STP were allowed to discharge during low stream flow.

2. The temperatures of the effluent and the stream are important because warmer temperatures increase reaction rates and may under some conditions decrease the quantity of oxygen present. However, temperature is not easily controlled, so it would not be considered a viable method to regulate effluent quality and in-stream water quality conditions.

3. Alteration of the BOD_5 concentration has a minor impact if the difference in required stream water is considered. A discharge containing 30 mg/L BOD_5 would require 1 cfs more stream water than a discharge containing 12 mg/L. Because of the relatively small difference (assuming the stream water is present), the 30 mg/L BOD effluent limit is used in Appendix V analyses.

4. Mill Creek's in-stream D.O. concentration appears to be impacted most by the effluent ammonia concentration. An increase in effluent ammonia concentration of 1 mg/L would require from 4 to 6 cfs more stream discharge to maintain the in-stream D.O. criterion. Ammonia is also important because it is toxic at certain concentrations in the un-ionized form. Conditions controlling the conversion of total ammonia to the un-ionized form varies with pH and temperature.

A method developed by Yake and James (1981) establishes effluent limitations for ammonia based upon specified conditions of stream flow, plant discharge, and the pH and temperature norms for an area. The pH and temperatures are used to calculate the percentage of ammonia in the un-ionized form (Table 4).

Table 4. Monthly mean percent un-ionized ammonia and standard deviation from WDOE station 32C110, Mill Creek.

Month	Mean	Standard Deviation
January	0.336	0.297
February	0.265	0.852
March	0.689	0.132
April	0.471	0.299
May	2.130	0.823
June	3.963	0.812
July	5.550	0.850
August	5.307	1.779
September	6.721	1.530
October	5.560	0.998
November	0.880	0.833
December	0.640	0.611

This method was used to determine permissible monthly effluent ammonia concentrations which could be discharged to Mill Creek by the Walla Walla STP. A 10 percent recurrence interval was used for the percent un-ionized ammonia with the 1-in-10-year low monthly flow.

The input and output data are presented in Table 5 and Appendix V, respectively. The monthly effluent ammonia-N limits range from <0.1 to 16.5 mg/L. Values in Table 5 represent amounts of NH_3-N which can be discharged and still maintain an in-stream un-ionized NH_3-N concentration below 0.016 mg/L-N. These values do not consider in-stream D.O. levels in terms of their impacts on the stream's D.O. standard. With the exception of January, these values would not cause in-stream D.O. violations. A minimum flow analysis using a modification of the D.O. model Mill 1 indicates that the in-stream D.O. standard would be maintained in January if the STP effluent contained 11 mg/L instead of 16.5 mg/L NH_3-N.

The ammonia effluent limitations in Table 5 for October, November, December, and possibly April are probably unattainable by the STP as it is now operated and designed. The model indicates that an effluent containing 3.6 mg/L NH_3 would cause D.O. violations in

Table 2. Water quality data from Mill Creek receiving water survey. Concentrations are given in mg/L unless otherwise noted.

		Station Number and Description													
		1	2		3	4	5	6		7		8	9	10	11
Parameter	Date	Tausick Road	Division Street	Point Source	Park street	Colville Street	4th Ave. Bridge	13th Ave. Bridge	Point Source	Upstream of STP	STP Effluent	Gose Street Bridge	Hussy Road Bridge	Highway 410	Mission Road
River Mile		10.0	8.1	7.8	7.7	7.4	6.9	6.3	6.2	5.6	5.4	4.8	4.35	2.7	0.4
Flow (cfs)	2/3	61	--	--	--	--	--	--	--		10.2				
	2/4	57	--	--	--	--	--	--	--	60.7		73	69	--	73
Temperature (°C)	2/3	2.0	2.0	19.4	2.0	3.8	3.0	3.0		2.0	10.4	4.0	3.0	3.0	3.0
	2/4	2.0	2.0		3.0	3.0	3.0	3.0	4.8	2.5		3.5	3.5	3.5	3.5
pH (S.U.)	2/3	7.9	7.7	8.4	7.7	7.8	7.9	8.0		7.9	7.5*	8.0	8.0	7.7	7.8
	2/4	8.1	8.1		7.9	8.1	8.1	8.3	7.9	8.0		8.0	8.0	7.8	7.9
Dissolved Oxygen	2/3	11.8	12.1		12.1	12.2	12.4	12.7		13.3	9.1	12.1	12.4	11.6	11.4
	2/4	12.2	12.4		12.6	12.7	12.8	13.3	—	13.3		12.5	12.5	11.9	11.7
% Dissolved Oxygen Sat.	2/3	88	90		90	96	95	97		99	81*	95	95	89	87
	2/4	91	93		97	97	98	102		101		97	97	92	91
Conductivity (umhos/cm)															
Field Data	2/3	75	79	215	85	89	86	83		84		120	111	150	172
Lab Data	2/3	73	70	209	76	79	78	80		85		110	112	124	165
Field Data	2/4	80	78		85	87	85	90	83	90		120	115	155	175
Lab Data	2/4	73	71		78	78	79	79	79	91*	265*	115	125*	144	164
Tot. Residual Chlorine	2/3										0.45	0.05	N.D.		
	2/4											0.05	N.D.		
Turbidity (NTU)	2/3	4				5				4	10*		4		2
	2/4	4				4				6*			5*		3
COD	2/3	9				4				9	55*		13		13
	2/4	9				9				13*			26*		17
BOD_5	2/3	1.2				4.9				1.7	11*		1.9		1.6
	2/4	1.7				1.6				2.3*			3.9*		1.2
BOD_{12}	2/3	1.9				7.5				2.8			4.5		
	2/4	2.3				2.6				3.3*			8.7*		
BOD_{15}	2/3	1.9				7.8				2.9			5.4		
	2/4	2.4				3.5				3.3*			9.3*		
BOD_{20}	2/3	2.4				8.1				3.4			6.2		
	2/4	2.6				4.5				4.0*			10.0*		
Fecal Coliform (org/100 ml)	2/3	6**	9**	<2**	20**	9**	17**	5**		10**	540	29**	140	9**	7**
	2/4	<2**	4**		<2**	6**	7**	10**	5**	8**	260	68	6**	8**	2**
NO_3-N	2/3	0.34	0.34	<0.01	0.38	0.41	0.42	0.42		0.45	5.35*	1.40	1.10	1.60	1.90
	2/4	0.39	0.35		0.38	0.40	0.40	0.43	0.38	0.47*		1.30	1.10*	1.70	2.20
NO_2-N	2/3	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	<0.05*	0.03	0.02	0.02	0.03
	2/4	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	0.02	<0.01*		0.02	0.03*	0.03	0.03
NH_3-N	2/3	<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01		<0.01	3.6*	0.60	0.21	0.20	0.13
	2/4	<0.01	<0.01		<0.01	<0.01	<0.01	<0.01	0.02	<0.01*		0.37	0.44*	0.28	0.18
Un-ionized NH_3-N	2/3										0.022*	0.007	0.002	0.001	0.001
	2/4								<0.001			0.004	0.005*	0.002	0.002
O-PO_4-P	2/3	0.03	0.03	0.01	0.03	0.03	0.03	0.03		0.03	2.45*	0.42	0.32	0.31	0.32
	2/4	0.04	0.03		0.03	0.03	0.04	0.04	0.09	0.04*		0.35	0.39*	0.35	0.35
T-PO_4-P	2/3	0.05	0.06	0.03	0.05	0.06	0.03	0.05		0.05	3.10*	0.56	0.40	0.37	0.36
	2/4	0.06	0.05		0.06	0.05	0.06	0.06	0.09	0.06*		0.43	0.50*	0.41	0.40
Total Solids	2/3	85				89				88	218*		110		140
	2/4	87				94				95*			120*		150
T. Non-Vol. Solids	2/3	58				75				71	140*		86		98
	2/4	59				69				75*			82*		100
Total Suspended Solids	2/3	3				4				2	11*		2		5
	2/4	4				1				2*			3*		2
T. Non-Vol. Susp. Solids	2/3	<1				<1				<1	2*		<1		<1
	2/4	<1				1				<1*			<1*		<1
Chlorides	2/3	1.5	<1.0	1.5	1.5	1.5	<1.0	2.3		2.3		3.1	3.1	6.9	9.2
	2/4	2.0	<1.0		2.0	2.0	1.0	2.0	1.5	2.0*		5.0	4.0*	8.0	9.0
T. Recoverable Copper	2/3	<0.01								<0.01			<0.01		<0.01
	2/4	<0.01								<0.01*			<0.01*		<0.01
T. Recoverable Zinc	2/3	<0.01								<0.01			<0.01		<0.01
	2/4	0.03								0.02*			0.02*		<0.01
T. Recoverable Iron	2/3	0.38								0.37			0.19		0.19
	2/4	0.40								0.40*			0.33*		0.22
T. Recoverable Nickel	2/3	0.05								<0.03			<0.03		<0.03
	2/4	<0.03								<0.03*			0.05*		0.05
T. Recoverable Chromium	2/3	<0.02								<0.02			<0.02		<0.02
	2/4	<0.02								<0.02*			<0.02*		<0.02
T. Recoverable Cadmium	2/3	<0.01								<0.01			<0.01		<0.01
	2/4	<0.01								<0.01*			<0.01*		<0.01
T. Recoverable Lead	2/3	<0.07								<0.07			<0.07		<0.07
	2/4	<0.07								<0.07*			<0.07*		<0.07
T. Recoverable Manganese	2/3	<0.02								<0.02			<0.02		<0.02
	2/4	<0.02								<0.02*			<0.02*		<0.02

*24-hour composite.
**Estimated counts.

October and November (Appendix V). Un-ionized ammonia toxicity would result October through December. The in-stream water quality violations under design conditions can only be adequately evaluated if and when the range of monthly effluent ammonia concentrations from the STP are determined. More data are needed to establish the plant's nitrification capabilities. When these data become available, additional evaluations can be made.

Recommendations

1. Require analysis of influent and effluent NH_3-N 24-hour composite samples at least weekly.

2. Determine level of NH_3-N and the nitrification efficiency when the plant treats BOD_5 to 30 mg/L and/or 12 mg/L.

3. When the above data become available, establish a discharge limit on NH_3-N which varies by month and a set BOD_5 limit of 30 mg/L, when discharging to the creek. The NH_3-N limitation should be a function of the 10-year low monthly flow or the minimum flow requirement during the months the STP discharges to the creek.

4. Investigate methods to eliminate STP discharge to Mill Creek during October and November. If discharge to Mill Creek during October and November is allowed, a minimum upstream flow of 20 cfs should be established. This will probably prevent in-stream ammonia toxicity and D.O. sags downstream of the STP. It could be adjusted when the additional ammonia data become available. A rating curve should be developed and a gage installed upstream of the STP to determine flows. Daily reporting of stream flows should be included on the monthly summaries and DMRs.

5. The STP does not report the date when the irrigation district takes the effluent. The date and percent of flow taken should be reported as the NPDES permit states.

6. Coordinate with the water master and require the water district(s) to provide adequate advance warning when they decide to divert the effluent. This time period for advance warning would be determined by the amount of time the STP requires to change plant processes such that the irrigation permit limitations could be met. The same notice would be required when the district discontinues use of the discharge.

7. Should investigate the possibility that the irrigation district continue to take the STP effluent until such time when adequate flow in Mill Creek exists. This, of course, would have obvious benefits to Mill Creek particularly during the late fall and spring

months when stream flows are very low. There would be offsetting considerations; i.e., possibly higher STP treatment costs and public opinion regarding the use of irrigation districts' waterways in preference to Mill Creek itself.

8. Coordinate with the water master to eliminate excess or unneeded diversion of Mill Creek waters to Yellowhawk and Garrison creeks during November and December.

9. In-stream chlorine toxicity needs to be alleviated.

Future Water Quality

As is evidenced in this memorandum, there have been conflicts with the beneficial uses of water in Mill Creek.

These low-flow conditions in Mill Creek are the result of the current irrigation practices. The effect of low flows combined with the addition of Walla Walla STP discharge can, and do, result in toxic conditions at times when fish passage may occur. These conflicts will undoubtedly remain and some planning is needed to mediate problems to enhance the quality of Mill Creek. Conversations with the water master, Harold Hansen; the treatment plant operator, Al Prouty; and the WDG indicate that very little, if any, coordination has ever occurred to minimize these impacts. It is quite likely that coordination could maximize water released to Mill Creek at times when the STP was discharging. This would ensure the greatest dilution possible and help resident and migrating fish.

LRS:JJ:cp

Attachments

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(1) CLASS AA (EXTRAORDINARY).

(a) General Characteristic. Water quality of this class shall markedly and uniformly exceed the requirements for all or substantially all uses.

(b) Characteristic Uses. Characteristic uses shall include, but are not limited to, the following:

(i) Water supply (domestic, industrial, agricultural).

(ii) Wildlife habitat, stock watering.

(iii) General recreation and aesthetic enjoyment (picknicking, hiking, fishing, swimming, skiing, and boating).

(iv) General marine recreation and navigation.

(v) Fish and shellfish reproduction, rearing, and harvesting.

(c) Water Quality Criteria.

(i) Fecal Coliform Organisms.

(A) Freshwater - Fecal Coliform Organisms shall not exceed a median value of 50 organisms/100 ml, with not more than 10 percent of samples exceeding 100 organisms/100 ml.

(B) Marine water - Fecal Coliform Organisms shall not exceed a median value of 14 organisms/100 ml, with not more than 10 percent of samples exceeding 43 organisms/100 ml.

(ii) Dissolved Oxygen.

(A) Freshwater - Dissolved Oxygen shall exceed 9.5 mg/l.

(B) Marine water - Dissolved Oxygen shall exceed 7.0 mg/l except when the natural phenomenon of upwelling occurs, natural dissolved oxygen levels can be degraded by up to 0.2 mg/l by man-caused activities.

(iii) Total dissolved gas - the concentration of total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

(iv) Temperature - water temperatures shall not exceed 16.0° Celsius (freshwater) or 13.0° Celsius (marine water) due to human activities. Temperature increases shall not, at any time, exceed $t = 23/(T+5)$ (freshwater) or $t = 8/(T-4)$ (marine water).

When natural conditions exceed 16.0° Celsius (freshwater) and 13.0° Celsius (marine water), no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3° Celsius.

For purposes hereof, "t" represents the permissive temperature change across the dilution zone; and "T" represents the highest existing temperature in this water classification outside of any dilution zone.

Provided that temperature increase resulting from non-point source activities shall not exceed 2.8° Celsius, and the maximum water temperature shall not exceed 16.3° Celsius (freshwater).

(v) pH shall be within the range of 6.5 to 8.5 (freshwater) or 7.0 to 8.5 (marine water) with a man-caused variation within a range of less than 0.2 units.

(vi) Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

(vii) Toxic, radioactive, or deleterious material concentrations shall be less than those which may affect public health, the natural aquatic environment, or the desirability of the water for any use.

(viii) Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

(2) CLASS A (EXCELLENT).

(a) General Characteristic. Water quality of this class shall meet or exceed the requirements for all or substantially all uses.

(b) Characteristic Uses. Characteristic uses shall include, but are not limited to, the following:

(i) Water supply (domestic, industrial, agricultural).

(ii) Wildlife habitat, stock watering.

(iii) General recreation and aesthetic enjoyment (picknicking, hiking, fishing, swimming, skiing, and boating).

(iv) Commerce and navigation.

(v) Fish and shellfish reproduction, rearing, and harvesting.

(c) Water Quality Criteria.

(i) Fecal Coliform Organisms.

(A) Freshwater - Fecal Coliform Organisms shall not exceed a median value of 100 organisms/100 ml, with not more than 10 percent of samples exceeding 200 organisms/100 ml.

(B) Marine water - Fecal Coliform Organisms shall not exceed a median value of 14 organisms/100 ml, with not more than 10 percent of samples exceeding 43 organisms/100 ml.

(ii) Dissolved Oxygen.

(A) Freshwater - Dissolved Oxygen shall exceed 8.0 mg/l.

(B) Marine water - Dissolved Oxygen shall exceed 6.0 mg/l, except when the natural phenomenon of upwelling occurs, natural dissolved oxygen levels can be degraded by up to 0.2 mg/l by man-caused activities.

(iii) Total Dissolved Gas - the concentration of total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

(iv) Temperature - water temperature shall not exceed 18.0° Celsius (freshwater) or 16.0° Celsius (marine water) due to human activities. Temperature increases shall not, at any time, exceed $t = 28/(T+7)$ (freshwater) or $t = 12(T-2)$ (marine water).

When natural conditions exceed 18.0° Celsius (freshwater) and 16.0° Celsius (marine water), no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3° Celsius.

For purposes hereof, "t" represents the permissive temperature change across the dilution zone; and "T" represents the highest existing temperature in this water classification outside of any dilution zone.

Provided that temperature increase resulting from nonpoint source activities shall not exceed 2.8° Celsius, and the maximum water temperature shall not exceed 18.3° Celsius (freshwater).

(v) pH shall be within the range of 6.5 to 8.5 (freshwater) or 7.0 to 8.5 (marine water) with a man-caused variation within a range of less than 0.5 units.

(vi) Turbidity shall not exceed 5 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 10 percent increase in turbidity when the background turbidity is more than 50 NTU.

(vii) Toxic, radioactive, or deleterious material concentrations shall be below those of public health significance, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect any water use.

(viii) Aesthetic values shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.

(3) CLASS B (GOOD).

(a) General Characteristic. Water quality of this class shall meet or exceed the requirements for most uses.

(b) Characteristic Uses. Characteristic uses shall include, but are not limited to, the following:

(i) Industrial and agricultural water supply.

(ii) Fishery and wildlife habitat.

(iii) General recreation and aesthetic enjoyment (picknicking, hiking, fishing, and boating).

(iv) Stock watering.

(v) Commerce and navigation.

(vi) Shellfish reproduction and rearing, and crustacea (crabs, shrimp, etc.) harvesting.

(c) Water Quality Criteria.

(i) Fecal Coliform Organisms.

(A) Freshwater - Fecal Coliform Organisms shall not exceed a median value of 200 organisms/100 ml, with not more than 10 percent of samples exceeding 400 organisms/100 ml.

(B) Marine water - Fecal Coliform Organisms shall not exceed a median value of 100 organisms/100 ml, with not more than 10 percent of samples exceeding 200 organisms/100 ml.

(ii) Dissolved Oxygen.

(A) Freshwater - Dissolved Oxygen shall exceed 6.5 mg/l or 70 percent saturation whichever is greater.

(B) Marine water - Dissolved Oxygen shall exceed 5.0 mg/l or 70 percent saturation, whichever is greater, except when the natural phenomenon of upwelling occurs, natural dissolved oxygen levels can be degraded by up to 0.2 mg/l by man-caused activities.

(iii) Total Dissolved Gas - the concentration of total dissolved gas shall not exceed 110 percent of saturation at any point of sample collection.

(iv) Temperature - water temperature shall not exceed 21.0° Celsius (freshwater) or 19.0° Celsius (marine water) due to human activities. Temperature increases shall not, at any time, exceed $t = 34/(T+9)$ (freshwater) or $t = 16/T$ (marine water).

When natural conditions exceed 21.0° Celsius (freshwater) and 19.0° Celsius (marine water), no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3° Celsius.

For purposes hereof, "t" represents the permissive temperature change across the dilution zone; and "T" represents the highest existing temperature in this water classification outside of any dilution zone.

Provided that temperature increase resulting from nonpoint source activities shall not exceed 2.8° Celsius, and the maximum water temperature shall not exceed 21.3° Celsius (freshwater).

(v) pH shall be within the range of 6.5 to 8.5 (freshwater) and 7.0 to 8.5 (marine water) with a man-caused variation within a range of less than 0.5 units.

(vi) Turbidity shall not exceed 10 NTU over background turbidity when the background turbidity is 50 NTU or less, or have more than a 20 percent increase in turbidity when the background turbidity is more than 50 NTU.

(vii) Toxic, radioactive, or deleterious material concentrations shall be below those which adversely affect public health during characteristic uses, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect characteristic water uses.

(viii) Aesthetic values shall not be reduced by dissolved, suspended, floating, or submerged matter not attributed to natural causes, so as to affect water use or taint the flesh of edible species.

APPENDIX II

DEPARTMENT OF ECOLOGY

AGENCY 21540000 RETRIEVAL ---- 19 MARCH 1982

OFFICE OF WATER PROGRAMS
WATER QUALITY MANAGEMENT DIVISION
WATER QUALITY INVESTIGATIONS SECTION

32C070 MILL CREEK AT MISSION STREET 14015400

STORET MINOR BASIN: LOWER COLUMBIA   STORET SUB BASIN: WALLA WALLA

LATITUDE: 46 02 32.0   ELEVATION (FEET): 610   WATER CLASS: B
LONGITUDE: 118 28 12.0   COUNTY: WALLA WALLA   SEGMENT: 15-32-04

AGENCY: 21540000   STATE: WASHINGTON   STA TYPE: STREAM

TERMINAL STREAM	1ST LEV MILES	2ND LEV MILES	3RD LEV MILES	4TH LEV MILES	5TH LEV MILES	6TH LEV MILES
1310001	313.50	035.80	000.40	.	.	.

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	00300 DISSOLVED OXYGEN mg/l	31504 TOTAL COLIFORM /100ml MF	31616 FECAL COLIFORM /100ml MF	31672 FECAL STREP /100ml PC	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00080 COLOR PT-CO UNITS
72/07/11	1115			19.0	11.1	8000	80L		7.7	17.0	565	84
72/07/25	0955			20.0	7.4	16000L	400		7.9	18.0	483	81
72/08/08	0835			20.0	7.3	7000	600		7.7	11.0	475	69
72/08/22	0815			18.2	5.0	4000	230		7.5	4.0	449	55
72/09/12	0845			14.6	6.1	9000	100		7.7	7.0	415	37
72/09/27	0830			10.2	6.9	14000	350		7.6	5.0	387	36
73/10/17	1425		6.2	14.6	14.7	18000			8.6	3.0	410	22
73/10/30	1250		2.5	10.9	10.2	8600			7.8	2.0	370	20
73/11/13	1320			8.3	9.6	100000L			7.5	30.0	83	84
73/11/27	1320			7.6	9.3	16000L			7.4	10.0	140	29
73/12/11	1255		340.0	5.0	11.5	65000			7.6	12.0	104	46
73/12/18	1345		670.0	6.5	11.2	82000	2000K	2700	7.6	30.0	75	54
74/01/08	1500		200.0	0.0	12.7				7.5	15.0	180	24
74/01/22	1400		640.0	5.3	12.1	30000	590	1100	7.5	15.0	100	50
74/02/05	1315		540.0	5.6	12.6	3800	250	900B	7.6	25.0	91	63
74/02/20	1300			7.1	12.1	11000	100	50	7.6	10.0	110	41
74/03/05	1315		215.0	7.2	11.3	2800	180	180	7.7	6.0	110	33
74/03/19	1330		440.0	7.5	12.0	24000B	10B	20B	7.6	19.0	86	34
74/04/02	1340		530.0	6.7	12.1	6100	60	40B	7.4	72.0	82	85
74/04/16	1240		392.0	10.2	11.6	8500B	6B	1B	7.5	10.0	90	27
74/05/07	1300		390.0	14.1	10.6	2100	0M	50	7.6	24.0	84	24
74/05/21	1220		93.0	14.3	12.3	1300	40B	70	8.3	10.0	130	36
74/06/04	1205		157.0	12.4	10.7	3500B	170	180	8.0	6.0	93	26
74/06/19	1315		150.0	21.0	8.5	40000L	0M	100	7.7	11.0	107	29
74/07/09	1310		55.0	22.6	10.3	50000B	350	180	8.0	4.0	220	22
74/07/23	1310		3.0	25.9	13.5	60000B	340B	230	8.6	4.0	430	35
74/08/06	1415		2.2	23.3	16.2	60000B	140	28B	9.3	4.0	390	
74/08/20	1415		0.2	23.7	17.4	50000B	50	30	9.1	5.0	520	34
74/09/04	1300		1.9	22.6	15.2	20000B	210	40	8.9	5.0	450	30
74/09/17	1445		2.5	22.3	16.0	400B	230	16B	8.8	6.0	420	39
74/10/08	1620		2.9	11.4	15.3	10000L	75B		8.7	4.0	450	30
74/10/22	1350		2.9	12.9	14.3	310000	30		8.6	3.0	430	19
74/11/05	1350		15.0	11.4	12.6	30000B	80		7.8	4.0	380	21
74/11/19	1315		20.0	10.3	12.7	70000	70B		8.1	4.0	330	28
74/12/03	1305		54.0	7.9	12.1	14000B	100B		8.0	4.0	200	15
74/12/17	1255		56.0	7.7	11.2	63000	40B		7.4	23.0	150	35

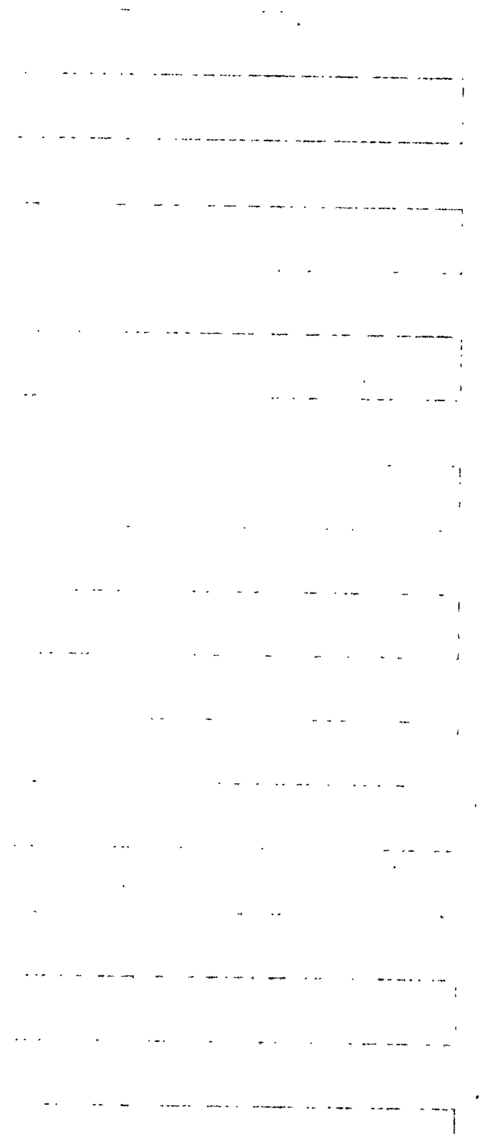
75/01/07	1510		88.0	4.2	10.9	500B	17B		7.6	9.0	150	18
75/01/21	1310		230.0	5.6	12.4	550B	11K		7.3	12.0	100	38
75/02/05	0835		122.0	1.7	13.6	2500	17B		7.1	6.0	140	24
75/02/11	1515		117.0	5.9	11.6				7.0	54.0	160	116
75/03/04	1510		427.0	8.0	11.8	1600I	80I		7.6	9.0	94	30
75/03/18	1350		178.0	8.1	10.3	46000B	1300		7.7	20.0	130	35
75/04/08	1435		65.0	9.9	11.9	14000	2008		7.3	4.0	130	19
75/04/22	1430		117.0	13.8	11.1	6300	45B		7.4	5.0	100	26
75/05/06	1430		150.0	13.7	10.9	850B	2K		8.2	6.0	97	20
75/05/20	1315		207.0	12.2	11.7	7800	34		7.7	12.0	105	17
75/06/03	1445		17.0	21.0	10.4	2600I	360H		8.5	3.0	140	25
75/06/17	1415		6.8	16.1	10.9	17000	750		8.2	4.0	150	21
75/07/15	1225		0.2	22.2	8.9	27600	700B		8.4	9.0	360	54
75/07/22	1505		0.08	29.0	3.5	6000I	1900		7.9	6.0	500	67
75/08/05	1450		0.08	21.6	1.8	400B	20K		7.3	2.0	530	21
75/08/19	1440		0.08	23.4	12.9	450I	240		8.1	5.0	370	25
75/09/09	1425		0.08	23.4	12.9	4600	480		8.4	6.0	200	13
75/09/23	1355		1.1	19.4	13.2	100B	84		8.6	2.0	410	13

DATE FROM TO	TIME	DEPTH METERS	00625 KJELDAHL NITROGEN T mg/l N	00630 NITROGEN NO2 + NO3 mg/l	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2 N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHORUS mg/l P	00665 TOTAL PHOSPHORUS mg/l P	00915 CALCIUM DIS Ca mg/l	00925 MAGNESIUM DIS Mg mg/l	00930 SODIUM DIS Na mg/l
72/07/11	1115				0.80	0.08	0.26	0.22	0.72	40.5	145.0	38.50
72/07/25	0955				0.98		0.32	0.27	0.93	16.5	11.0	33.00
72/08/08	0835				1.12	0.01	0.14	0.24	0.27	15.4	13.3	32.50
72/08/22	0815				0.90	0.01	0.08	0.17	0.44	19.1	10.6	32.00
72/09/12	0845				0.91	0.08	0.08	0.32	0.65	17.9	150.0	31.00
72/09/27	0830				1.22		0.06	0.46	0.81	8.7	9.8	30.80
73/10/17	1425		0.390		2.30	0.01	0.07	0.27	0.31	28.0	12.0	29.00
73/10/30	1250		0.380		3.30	0.01	0.10	0.56	0.60	25.0	11.0	25.00
73/11/13	1320		0.640		0.61	0.01	0.15	0.07	0.30	6.9	2.6	4.00
73/11/27	1320		0.570		1.10	0.02	0.05	0.22	0.32	11.0	4.2	9.10
73/12/11	1255		0.430		1.10	0.01	0.09	0.14	0.26	8.2	3.3	5.40
73/12/18	1345		0.340		0.55	0.01	0.21	0.04	0.25	6.2	2.4	3.40
74/01/08	1500		0.540		2.40	0.01	0.14	0.24	0.30	13.0	5.4	8.90
74/01/22	1400		0.370		1.20	0.01	0.10	0.06	0.18	7.8	3.3	12.00
74/02/05	1315		0.650		0.94	0.01	0.12	0.09	0.20	7.3	3.0	4.40
74/02/20	1300		0.360		1.10	0.01	0.06	0.10	0.16	8.5	3.5	5.50
74/03/05	1315		0.280		1.30	0.01	0.08	0.16	0.21	9.4	3.5	5.90
74/03/19	1330		0.360		0.73	0.01	0.10	0.09	0.19	6.6	2.6	3.90
74/04/02	1340		1.100		0.52	0.02	0.08	0.03	0.50	6.2	2.3	3.70
74/04/16	1240		0.320		0.75	0.01	0.07	0.13	0.15	7.2	2.7	4.30
74/05/07	1300		0.540		0.48	0.01	0.07	0.06	0.21	6.0	2.2	4.50
74/05/21	1220		0.490		0.83	0.01	0.12	0.17	0.24	9.3	3.4	6.20
74/06/04	1205		0.270		0.49	0.01	0.11	0.07	0.08	5.7	2.3	4.10
74/06/19	1315		0.350		0.79	0.01	0.08	0.12	0.17	7.1	2.9	4.70
74/07/09	1310		0.390		1.40	0.01	0.06	0.26	0.30	16.0	6.2	13.00
74/07/23	1310		0.480		0.91	0.01	0.10	0.14	0.20	30.0	13.0	29.00
74/08/06	1415		0.500		0.23	0.01	0.05	0.14	0.18	28.0	12.0	26.00
74/08/20	1415		0.480		0.15	0.01	0.11	0.11	0.14	34.0	15.0	31.00
74/09/04	1300		0.840		0.27	0.02	0.26	0.11	0.15	30.0	14.0	28.00
74/09/17	1445		0.460		0.88	0.01	0.05	0.17	0.25	31.0	14.0	28.00
74/10/08	1620			1.80			0.07	0.10	0.18	32.0	12.0	31.00
74/10/22	1350			3.20			0.12	0.17	0.26	42.0	12.0	27.00
74/11/05	1350			5.60			0.09	0.70	0.97	32.0	9.7	26.00
74/11/19	1315			4.20			0.05	0.97	1.10	26.0	9.8	23.00
74/12/03	1305			2.60			0.06	0.50	0.64	18.0	5.8	11.00
74/12/17	1255			1.50			0.16	0.24	0.66	13.0	4.7	8.20
75/01/07	1510			1.90			0.23	0.25	0.37	13.0	4.9	7.50
75/01/21	1310			0.93			0.14	0.12	0.19	10.0	3.0	4.80
75/02/05	0835			1.70			0.13	0.09	0.26	10.0	4.9	13.00
75/02/11	1515			1.70			0.55	0.28	0.44	11.0	4.7	8.90

75/03/04	1510		[illegible]		0.06	[illegible]	[illegible]	[illegible]	[illegible]	4.40
75/03/18	1350		1.30		0.12	0.19	0.25	9.7	4.3	5.80
75/04/08	1435		1.30		0.02	0.24	0.30	10.0	4.0	6.90
75/04/22	1430		0.77		0.06	0.13	0.22	9.6	3.5	5.70
75/05/06	1430		0.59		0.07	0.08	0.16	8.0	3.0	4.70
75/05/20	1315		0.79		0.06	0.11	0.18	8.3	2.8	5.70
75/06/03	1445		1.10		0.06	0.18	0.26	11.0	4.0	7.20
75/06/17	1415		1.10		0.09	0.13	0.22	14.0	5.3	8.20
75/07/15	1225		1.20		0.18	0.47	0.50	31.0	11.0	22.00
75/07/22	1505	0.950	2.30	0.08	0.15	0.64	0.88	39.0	14.0	31.00
75/08/05	1450		0.32		0.13	0.13	0.22	49.0	20.0	36.00
75/08/19	1440		2.00		0.08	0.15	0.21			25.00
75/09/09	1425		0.53		0.10	0.07	0.09	23.0	4.2	11.00
75/09/23	1355		1.60		0.05	0.14	0.19	35.0	13.0	27.00

DATE FROM TO	TIME	DEPTH METERS	00440 BICARB HCO3 ION mg/l	00945 SULFATE TOT SO4 mg/l	00940 CHLORIDE Cl mg/l	00935 POTASSIUM DIS K mg/l	00900 HARDNESS TOT CACO3 mg/l	00902 HARDNESS NC CACO3 mg/l	00410 ALKALINE T CACO3 mg/l	00445 CARBONATE CO3 ION mg/l
72/07/11	1115		199	14.0	56.0	8.40	200.0		163	
72/07/25	0955		156	11.0	24.0	9.10	87.0		128	
72/08/08	0835		161	9.0	87.0	9.00	132.0		96	0
72/08/22	0815		150	10.0	72.0	11.00	123.0		91	0
72/09/12	0845		152	11.0	15.0	9.10	125.0		660	0
72/09/27	0830		135	12.0	42.0	8.50	40.3		111	0
73/10/17	1425		151	18.0	31.0	7.10	120.0	0	124	
73/10/30	1250		128	16.0	27.0	7.20	110.0	3	105	
73/11/13	1320		41	3.4	2.6	2.70	28.0	0	34	
73/11/27	1320		60	4.5	5.9	4.10	45.0	0	49	
73/12/11	1255		48	4.1	3.2	2.90	34.0	0	39	
73/12/18	1345		35	2.9	2.0	2.00	25.0	0	29	
74/01/08	1500		62	7.6	7.6	3.30	55.0	4	51	
74/01/22	1400		41	3.7	3.3	2.20	33.0	0	34	
74/02/05	1315		37	4.0	2.6	2.10	31.0	0	30	
74/02/20	1300		43	4.0	3.5	2.30	36.0	0	35	
74/03/05	1315		46	4.1	3.8	2.60	38.0	0	38	
74/03/19	1330		35	2.8	1.6	2.10	27.0	0	29	
74/04/02	1340		34	2.5	1.9	1.90	25.0	0	28	
74/04/16	1240		37	3.3	1.6	2.10	29.0	0	30	
74/05/07	1300		35	3.4	2.4	2.30	24.0	0	29	
74/05/21	1220		50	5.3	4.2	2.60	37.0	0	41	
74/06/04	1205		39	3.9	2.8	3.10	24.0	0	32	
74/06/19	1315		42	3.5	3.2	1.80	30.0	0	34	
74/07/09	1310		86	9.7	11.0	4.40	65.0	~~0~~	~~[illegible]~~	
74/07/23	1310		172	20.0	31.0	6.70	130.0	0	141	
74/08/06	1415		153	17.0	32.0	5.70	120.0	0	126	
74/08/20	1415		182	17.0	36.0	2.60	150.0	0	149	
74/09/04	1300		170	17.0	35.0	7.10	130.0	0	139	
74/09/17	1445		170	17.0	31.0	5.10	140.0	0	139	
74/10/08	1620		165	20.0	32.0	6.50	130.0	0	135	
74/10/22	1350		142	18.0	30.0	6.30	150.0	38	116	
74/11/05	1350		118	16.0	24.0	6.10	120.0	23	97	
74/11/19	1315		109	13.0	22.0	6.10	110.0	16	89	
74/12/03	1305		73	7.1	10.0	4.00	63.0	3	60	
74/12/17	1255		59	5.9	6.4	3.50	52.0	3	48	
75/01/07	1510		60	5.7	6.5	3.60	53.0	3	49	
75/01/21	1310		38	6.8	2.8	2.40	37.0	6	31	
75/02/05	0835		46	6.3	7.5	6.50	45.0	7	38	
75/02/11	1515		59	7.0	7.2	3.30	49.0	1	48	
75/03/04	1510		40	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	
75/03/18	1350		50	4.7	4.2	2.80	42.0	1	41	
75/04/08	1435		53	4.3	5.8	2.60	41.0	0	43	
75/04/22	1430		45	3.3	3.4	2.30	38.0	1	37	
75/05/06	1430		44	[illegible]	[illegible]	[illegible]	[illegible]	0	[illegible]	

	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	4[illegible]
75/06/03 1445	60	4.7	6.0	2.80	44.0	0	49
75/06/17 1415	67	4.2	5.8	2.90	57.0	2	55
75/07/15 1225	149	16.0	17.0	7.40	120.0	0	122
75/07/22 1505	174	24.0	24.0	8.40	160.0	12	14[illegible]
75/08/05 1450	264	26.0	28.0	9.60	200.0		217
75/08/19 1440	129	14.0	29.0	6.10	170.0		106
75/09/03 1425	105	8.0	4.0	4.70	75.0		86
75/09/23 1755	162	17.0	31.0	6.20	140.0		133



DEPARTMENT OF ECOLOGY

AGENCY 21540000 RETRIEVAL --- 19 MARCH 1982

OFFICE OF WATER PROGRAMS
WATER QUALITY MANAGEMENT DIVISION
WATER QUALITY INVESTIGATIONS SECTION

32C110 MILL CREEK AT TAUSICK WAY 14015002

STORET MINOR BASIN: LOWER COLUMBIA STORET SUB BASIN: WALLA WALLA

LATITUDE: 46 04 34.0 ELEVATION (FEET): 1140 WATER CLASS: A
LONGITUDE: 118 16 58.0 COUNTY: WALLA WALLA SEGMENT: 15-32-04

AGENCY: 21540000 STATE: WASHINGTON STA TYPE: STREAM

TERMINAL STREAM	1ST LEV MILES	2ND LEV MILES	3RD LEV MILES	4TH LEV MILES	5TH LEV MILES	6TH LEV MILES
1310001	313.50	035.80	010.00	.	.	.

DATE FROM TO	TIME	DEPTH METERS	00060 STREAM FLOW CFS-AVG	00010 WATER TEMP DEG-C	00300 DISSOLVED OXYGEN mg/l	31504 TOTAL COLIFORM /100ml MF	31616 FECAL COLIFORM /100ml MF	31672 FECAL STREP /100ml PC	00400 pH STANDARD UNITS	00070 TURBIDITY TURBMETER NTU	00095 CONDUCTVY @ 25 C MICROMHOS	00080 COLOR PT-CO UNITS
72/07/11	0940			16.6	11.0	800	80		7.8	4.0	113	22
72/07/25	0755			18.0	7.7	4000	80L		7.8	4.0	102	18
72/08/08	0730			22.4	6.9	6000	330		7.5	5.0	118	27
72/08/22	0715			18.5	7.5	9000	340		7.7	3.0	118	44
72/09/12	0750			13.1	8.5	7000	250		4.0			19
72/09/27	0730			9.8	9.2	5000	250		7.7	3.0	105	16
73/10/17	1245			12.6	11.2	630			7.9	2.0	110	18
73/10/30	1100			9.2	10.7	580			7.8	2.0	110	20
73/11/13	1110			7.6	10.8	2000			7.7	21.0	65	73
73/11/27	1125			6.0	12.0	1800			7.8	10.0	84	25
73/12/11	1140			5.3	12.2	560			7.6	11.0	69	51
73/12/18	1130		538.0	6.2	11.5	1600	40	40	7.6	17.0	59	52
74/01/08	1305		87.0	0.0	13.1				7.6	30.0	92	29
74/01/22	1140		292.0	4.5	12.2	480	13B	2B	7.6	15.0	67	52
74/02/05	1130		460.0	4.3	12.9	1200	10B	12B	7.6	25.0	63	55
74/02/20	1135		280.0	4.9	13.3	730	4B	3B	7.6	15.0	67	37
74/03/05	1130		172.0	5.7	11.6	340	8B	6B	7.7	7.0	72	37
74/03/19	1215		146.0	6.1	12.5	660	2B	5B	7.5	11.0	74	34
74/04/02	1220		460.0	4.8	12.7	2000	100	30B	7.4	81.0	64	66
74/04/16	1110		353.0	7.6	12.4	640	4B	4B	7.6	10.0	65	28
74/05/07	1155		331.0	11.4	11.4	340	10B	20	7.9	12.0	56	21
74/05/21	1120		108.0	10.7	11.7	200	5B	4B	8.3	6.0	75	20
74/06/04	1115		214.0	10.5	10.8	8000L	160L	200	7.6	26.0	59	77
74/06/19	1155		128.0	16.7	9.1	1700B	40B	36B	7.6	12.0	63	21
74/07/09	1210		29.0	16.7	9.8	3700	100	40	7.8	4.0	88	7
74/07/23	1205		0.3	19.8	10.1	1400B	40	100	8.3	3.0	120	23
74/08/06	1305		0.4	18.6	9.2	400B	50	60	8.3	5.0	110	
74/08/20	1320		0.3	17.7	10.9	800B	20	90	8.3	4.0	130	16
74/09/04	1205		0.3	18.1	10.0	2500L	70	160	8.2	5.0	120	13
74/09/17	1320		0.3	18.3	10.6	1600B	12B	26B	7.9	3.0	120	22

DATE FROM TO	TIME	DEPTH METERS	00625 KJELDAHL NITROGEN T mg/l N	00620 NITRATE T NO3-N mg/l	00615 NITRITE T NO2-N mg/l	00610 AMMONIA T NH3-N mg/l	00671 DIS-ORTHO PHOSPHRUS mg/l P	00665 TOTAL PHOSPHRUS mg/l P	00915 CALCIUM DIS Ca mg/l	00925 MAGNESIUM DIS Mg mg/l	00930 SODIUM DIS Na mg/l	00440 BICARB HCO3 ION mg/l

72/07/11	0940		0.29	0.00K	0.08	0.02	0.05	10.4	3.6	4.00	60
72/07/25	0755		0.10	0.00K	0.04	0.04	0.06	1.8	2.9	3.40	54
72/08/08	0730		0.40	0.00	0.04	0.06	0.07		3.6	4.70	59
72/08/22	0715		0.17	0.01	0.06	0.01	0.06	2.7	3.7	4.20	66
72/09/12	0750		0.13	0.00	0.00	0.03	0.06	2.5	3.3	4.20	62
72/09/27	0730		0.11		0.00	0.03	0.05	2.3	3.2	4.60	57
73/10/17	1245	0.160	0.11	0.00	0.07	0.03	0.04	9.5	4.0	4.60	64
73/10/30	1100	0.190	0.09	0.00	0.08	0.04	0.05	9.7	4.0	4.90	63
73/11/13	1110	0.400	0.46	0.00	0.17	0.02	0.14	5.7	2.3	2.90	33
73/11/27	1125	0.220	0.70	0.00	0.04	0.04	0.06	7.3	2.7	3.70	43
73/12/11	1140	0.210	0.59	0.00	0.06	0.04	0.08	5.8	2.3	2.90	36
73/12/18	1130	0.310	0.29	0.00	0.15	0.02	0.12	5.1	1.9	2.30	31
74/01/08	1305	0.510	1.20	0.00	0.12	0.05	0.17	7.2	2.9	3.50	40
74/01/22	1140	0.250	0.73	0.00	0.09	0.04	0.10	5.6	2.3	3.00	31
74/02/05	1130	0.300	0.53	0.01	0.10	0.04	0.14	5.3	2.1	2.60	29
74/02/20	1135	0.220	0.55	0.00	0.11	0.04	0.08	5.7	2.3	3.10	32
74/03/05	1130	0.220	0.60	0.01	0.10	0.04	0.06	6.2	2.2	3.20	34
74/03/19	1215	0.170	0.28	0.01	0.08	0.03	0.09	5.0	1.9	2.80	28
74/04/02	1220	0.520	0.31	0.01	0.10	0.02	0.26	5.1	1.7	3.40	27
74/04/16	~~1110~~	~~0.170~~	~~0.38~~	~~0.00~~	0.04	0.04	0.05	5.8	2.0	3.00	32
74/05/07	1155	0.160	0.11	0.00	0.03	0.01	0.06	4.3	1.5	2.70	28
74/05/21	1120	0.220	0.07	0.00	0.05	0.02	0.04	5.8	2.2	3.10	37
74/06/04	1115	0.580	0.15	0.01	0.19	0.02	0.15	4.6	1.7	2.50	29
74/06/19	1155	0.220	0.19	0.01	0.04	0.03	0.12	4.5	1.6	2.20	31
74/07/09	1210	0.160	0.22	0.01	0.05	0.04	0.06	7.6	2.8	2.90	47
74/07/23	1205	0.370	0.29	0.00	0.09	0.04	0.04	10.0	3.8	4.40	65
74/08/06	1305	0.330	0.36	0.01	0.08	0.04	0.06	10.0	4.6	5.10	62
74/08/20	1320		0.22	0.01	0.04	0.03	0.04	12.0	4.2	4.40	61
74/09/04	1205	0.300	0.21	0.01	0.03	0.04	0.04	11.0	4.1	5.90	64
74/09/17	1320	0.220	0.19	0.01	0.03	0.04	0.05	9.9	5.0	3.80	64

DATE FROM TO	TIME	DEPTH METERS	00945 SULFATE TOT SO4 mg/l	00940 CHLORIDE Cl mg/l	00935 POTASSIUM DIS K mg/l	00900 HARDNESS TOT CaCO3 mg/l	00902 HARDNESS NC CaCO3 mg/l	00410 ALKALINE T CaCO3 mg/l	00445 CARBONATE CO3 ION mg/l
72/07/11	0940		3.0	1.0	2.60	41.0		49	
72/07/25	0755		0.0	1.0	2.60	16.0		44	
72/08/08	0730		0.0	1.0K	3.00	48.0		2	0
72/08/22	0715		0.0	2.0	0.30	46.0		22	0
72/09/12	0750		1.0	2.0	2.40	51.0		20	0
72/09/27	0730		9.0	1.0	2.50	18.9		47	0
73/10/17	1245		2.7	0.8	2.90	40.0	0	52	
73/10/30	1100		1.6	1.3	2.90	41.0	0	52	
73/11/13	1110		2.9	1.2	1.90	24.0	0	27	
73/11/27	1125		3.0	1.9	2.10	29.0	0	35	
73/12/11	1140		2.4	0.8	1.80	24.0	0	30	
73/12/18	1130		2.4	1.0	1.60	21.0	0	25	
74/01/08	1305		2.9	1.1	2.00	30.0	0	33	
74/01/22	1140		2.4	1.1	1.70	23.0	0	25	
74/02/05	1130		2.7	1.1	1.60	22.0	0	24	
74/02/20	1135		2.4	0.9	1.80	24.0	0	26	
74/03/05	1130		2.1	0.8	1.80	25.0	0	28	
74/03/19	1215		1.9	0.3	1.70	20.0	0	23	
74/04/02	1220		1.9	1.3	1.60	20.0	0	22	
74/04/16	1110		2.0	0.3	1.70	23.0	0	26	
74/05/07	1155		2.3	0.8	1.50	17.0	0	23	
74/05/21	1120		2.4	0.8	1.70	24.0	0	30	
74/06/04	1115		2.8	1.5	1.00	18.0	0	24	
74/06/19	1155		1.5	0.7	1.20	18.0	0	25	
74/07/09	1210		3.1	0.9	2.30	31.0	0	39	
74/07/23	1205		3.6	2.0	3.00	41.0	0	53	
74/08/06	1305		4.6	2.2	2.40	44.0	0	51	
74/08/20	1320		2.9	1.4	2.80	47.0	0	50	

APPENDIX III

```
0010  DEFFN'30 "Q$=";HEX(22);"MILL1";HEX(223A);"SCRATCH F Q$";HEX(0D)
0020  DEFFN'31 "SAVE DC F$(Q$)Q$";HEX(0D)
0030 REM %

PROGRAM NAME--- MILL1

0040 REM THIS MODELS THE DO CONCENTRATION IN MILL CREEK NR. WALLA WALLA
0050 REM PROGRAMMER LYNN SINGLETON
0060 REM APRIL, 1981
0070 REM SOURCES; HAMMER AND MACKICHAN, 1980 AND YAKE, 1981
0080 P1=760
0090 REM %

********** INPUT MODULE **********

0100 INPUT "PLANT FLOW (CFS)",F2
0110 INPUT  "TEMP UP,PLANT TEMP",T1,T2
0120 INPUT "D.O. UP,PLANT D.O.",D1,D2
0130 INPUT "NH3-N UP, PLANT NH3-N",N1,N2
0140 INPUT "IS BOD FIVE DAY (1) OR ULTIMATE (2)",C
0150 INPUT "ENTER BOD UP, PLANT BOD",C1,C2
0160 INPUT "ENTER CALCULATION INTERVAL (MILES)",I5
0170 PRINT HEX(0C0A0A)
0180 REM %

*******************************

0190 FOR I=1 TO 4
0200 READ F1,V,Z
0210 IF I=2 THEN F1=25-F2
0220 GOSUB 540
0230 D6=5
    : IF D5/2>5 THEN D6=D5/2
0240 GOSUB 750
0250 FOR T5 =0 TO 5.4 STEP I5
0260 GOSUB 1050
0270 IF X=1 THEN 300
0280 PRINT "RIVER MILE","DAYS","D.O.","DEFICIT"
0290 X=1
0300 PRINT ROUND(R,2),ROUND(T,2),ROUND(D,2),ROUND(D9,2)
0310 NEXT T5
0320 X=0
0330 PRINT HEX(0C)
0340 IF Y=1 THEN 410
0350 NEXT I
0360 IF R1>=20 THEN 410
0370 F1=20*F2
    : Y=1
    : GOTO 220

0380 REM UPSTREAM FLOW, MEAN VEL., MEAN DEPTH, AND REPEATS
0390 DATA 0,.43,.6,15,.92,.9,61,2.26,.9,204,3.7,1.4
```

```
0400 REM ********** MINIMUM FLOW ANALYSIS **********
0410 PRINT
0420 FOR F1=61 TO  5 STEP -1
0430 V=.01*(F1+F2)+.36
   : Z=.9
0440 GOSUB 540
0450 FOR T5=0 TO 5.4 STEP .2
0460 GOSUB 1050
0470 IF D>D6 THEN 500
0480 PRINT "MINIMUM FLOW UNDER SPECIFIED CONDITIONS IS ";F1;"CFS"
0490 GOTO 530

0500 NEXT T5
0510 NEXT F1
0520 PRINT "NO DISSOLVED OXYGEN CRITERION VIOLATIONS OCCUR WITHIN RANGE"
0530 END

0540 REM %

**   I N I T I A L   C A L C U L A T I O N S   S U B R O U T I N E   **

0550 R1=F1/F2
0560 C0=(F1*D1+F2*D2)/(F1+F2)
0570 T0=(F1*T1+F2*T2)/(F1+F2)
0580 N0=((F1*N1+F2*N2)/(F1+F2))*4.33
0590 REM ********* D.O. % SAT *********
0600 P=(P1-4.87922*EXP(.06378*T0))/(760-4.87922*EXP(.06378*T0))
0610 D5=(14.6214-.4026*T0+6.8516E-03*T0↑2+2.2619E-04*T0↑3-2.4998E-05*T0↑4+8.5254
     E-07*T0↑5-1.0513E-08*T0↑6)*P
0620 K1=.09
0630 K1=K1*1.047↑(T0-20)
0640 K2=2.2*(V/Z↑1.33)
0650 K2=K2*1.022↑(T0-20)
0660 K3=9.82
0670 IF C=2 THEN 710
0680 B1=C1/(1-EXP(-5*K1))
0690 B2=C2/(1-EXP(-5*K1))
0700 GOTO 720

0710 B1=C1
   : B2=C2
0720 L0=(F1*B1+F2*B2)/(F1+F2)
0730 D0=D5-C0
0740 RETURN

0750 REM %

*****   P R I N T   S U B R O U T I N E   *****

0760 PRINT HEX(0E);TAB(4);"MILL CREEK D.O. MODEL"
0770 PRINT HEX(0E);TAB(2);"INSTREAM D.O. CRITERION";ROUND(D6,2);"MG/L"
0780 PRINT
0790 PRINT "*********************** INPUT ECHO ***********************"
```

```
0800 PRINT  "PLANT FLOW (CFS)     ",F2
0810 PRINT  "TEMP UP,PLANT TEMP",T1,T2
0820 PRINT "D.O. UP,PLANT D.O.",D1,D2
0830 PRINT "NH3-N UP, PLANT NH3-N",N1,N2
0840 IF C=2 THEN 870
0850 PRINT "FIVE DAY BOD UP, PLANT BOD=",C1,C2
0860 GOTO 890
0870 PRINT "ULTIMATE BOD UP, PLANT BOD=",C1,C2
0880 B1=C1
   : B2=C2
0890 PRINT "*************************************************************"
0900 PRINT HEX(0A0A)
0910 PRINT "UPSTREAM FLOW (CFS)          ";F1
0920 PRINT "PLANT FLOW (CFS)             ";F2
0930 PRINT "DOWNSTREAM FLOW (CFS)        ";F1+F2
0940 PRINT "DILUTION RATIO               ";ROUND(R1,2)
0950 PRINT "MIXED ULT. BOD (MG/L)        ";ROUND(L0,2)
0960 PRINT "MIXED ULT. NOD (MG/L)        ";ROUND(N0,2)
0970 PRINT "MIXED TEMPERATURE (C)        ";ROUND(T0,2)
0980 PRINT "MIXED D.O. (MG/L)            ";ROUND(C0,2)
0990 PRINT "D.O. 100% SAT =              ";ROUND(D5,2)
1000 PRINT "K1=                          ";ROUND(K1,2)
1010 PRINT "K2=                          ";ROUND(K2,2)
1020 PRINT "K3=                          ";ROUND(K3,2)
1030 PRINT HEX(0A0A)
1040 RETURN

1050 REM %

***** STREAM MODEL SUBROUTINE *****

1060 R=5.4-T5
1070 T=(T5/V)*(5280/86400)
1080 IF T5=0 THEN T=.00001
1090 D9=(K1*L0)/(K2-K1)*(EXP(-K1*T)-EXP(-K2*T))+(K3*N0)/(K2-K3)*(EXP(-K3*T)-EXP(
     -K2*T))+D0*EXP(-K2*T)
1100 D=D5-D9
1110 RETURN
```

APPENDIX IV

MILL CREEK D.O. MODEL

[illegible] D.O. CRITERION [illegible] MG/L

************************ INPUT DATA ************************

PLANT FLOW (CFS)	10.2	
TEMP UP,PLANT TEMP	2.3	10.4
D.O. UP,PLANT D.O	13.3	9.1
NH3-N UP, PLANT NH3-N	0	3.6
ULTIMATE BOD UP, PLANT BOD=	4.1	22.2

****

UPSTREAM FLOW (CFS)	0
PLANT FLOW (CFS)	10.2
DOWNSTREAM FLOW (CFS)	10.2
DILUTION RATIO	0
MIXED ULT. BOD (MG/L)	22.2
MIXED ULT. NOD (MG/L)	15.59
MIXED TEMPERATURE (C)	10.4
MIXED D.O. (MG/L)	9.1
D.O. 100% SAT =	11.23
K1=	.06
K2=	1.51
K3=	9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	9.1	2.13
5.2	.03	5.44	5.79
5	.06	2.84	8.39
4.8	.09	1.04	10.19
4.6	.11	-.18	11.41
4.4	.14	-.95	12.18
4.2	.17	-1.39	12.62
4	.2	-1.59	12.82
3.8	.23	-1.61	12.84
3.6	.26	-1.5	12.73
3.4	.28	-1.3	12.53
3.2	.31	-1.04	12.27
3	.34	-.73	11.96
2.8	.37	-.39	11.62
2.6	.4	-.03	11.26
2.4	.43	.33	10.9
2.2	.45	.7	10.53
2	.48	1.06	10.16
1.8	.51	1.43	9.8
1.6	.54	1.78	9.45
1.4	.57	2.12	9.1
1.2	.6	2.46	8.77
1	.63	2.78	8.44
.8	.65	3.1	8.13
.6	.68	3.4	7.83
.4	.71	3.69	7.54
.2	.74	3.97	7.26
0	.77	4.24	6.99

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 6.0 MG/L

****************************** INPUT FORM ******************************

PLANT FLOW (CFS)	10.2	
TEMP UP, PLANT TEMP	2.3	10.4
D.O. UP, PLANT D.O.	13.3	9.1
NH3-N UP, PLANT NH3-N	0	3.6
ULTIMATE BOD UP, PLANT BOD=	4.1	22.2

****

UPSTREAM FLOW (CFS)	14.8
PLANT FLOW (CFS)	10.2
DOWNSTREAM FLOW (CFS)	25
DILUTION RATIO	1.45
MIXED ULT. BOD (MG/L)	11.48
MIXED ULT. NOD (MG/L)	6.36
MIXED TEMPERATURE (C)	5.6
MIXED D.O. (MG/L)	11.59
D.O. 100% SAT =	12.6
K1=	.05
K2=	1.7
K3=	9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	11.59	1.01
5.2	.01	10.83	1.77
5	.03	10.19	2.41
4.8	.04	9.65	2.95
4.6	.05	9.18	3.42
4.4	.07	8.8	3.8
4.2	.08	8.47	4.12
4	.09	8.21	4.39
3.8	.11	7.99	4.61
3.6	.12	7.82	4.78
3.4	.13	7.68	4.92
3.2	.15	7.57	5.03
3	.16	7.5	5.1
2.8	.17	7.44	5.16
2.6	.19	7.41	5.19
2.4	.2	7.39	5.2
2.2	.21	7.4	5.2
2	.23	7.41	5.19
1.8	.24	7.44	5.16
1.6	.25	7.47	5.13
1.4	.27	7.51	5.09
1.2	.28	7.56	5.04
1	.29	7.62	4.98
.8	.31	7.68	4.92
.6	.32	7.75	4.85
.4	.33	7.81	4.79
.2	.35	7.88	4.72
0	.36	7.96	4.64

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 6.66 MG/L

********************** INPUT ECHO ****************************

PLANT FLOW (CFS)	10.2	
TEMP UP,PLANT TEMP	2.3	10.4
D.O. UP,PLANT D.O.	13.3	9.1
NH3-N UP, PLANT NH3-N	0	3.6
ULTIMATE BOD UP, PLANT BOD=	4.1	22.2

****

UPSTREAM FLOW (CFS)	61
PLANT FLOW (CFS)	10.2
DOWNSTREAM FLOW (CFS)	71.2
DILUTION RATIO	5.98
MIXED ULT. BOD (MG/L)	6.69
MIXED ULT. NOD (MG/L)	2.23
MIXED TEMPERATURE (C)	3.46
MIXED D.O. (MG/L)	12.7
D.O. 100% SAT =	13.32
K1=	.04
K2=	3.99
K3=	9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	12.7	.62
5.2	.01	12.6	.72
5	.01	12.5	.82
4.8	.02	12.41	.9
4.6	.02	12.33	.98
4.4	.03	12.26	1.05
4.2	.03	12.2	1.12
4	.04	12.13	1.18
3.8	.04	12.08	1.24
3.6	.05	12.03	1.29
3.4	.05	11.98	1.33
3.2	.06	11.94	1.37
3	.06	11.91	1.41
2.8	.07	11.88	1.44
2.6	.08	11.85	1.47
2.4	.08	11.82	1.49
2.2	.09	11.8	1.51
2	.09	11.79	1.53
1.8	.1	11.77	1.55
1.6	.1	11.76	1.56
1.4	.11	11.75	1.57
1.2	.11	11.74	1.58
1	.12	11.73	1.58
.8	.12	11.73	1.58
.6	.13	11.73	1.59
.4	.14	11.73	1.59
.2	.14	11.73	1.58
0	.15	11.74	1.58

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5.8 MG/L

************************* INPUT ECHO ***************************

PLANT FLOW (CFS)	10.2	
TEMP UP,PLANT TEMP	2.3	10.4
D.O. UP,PLANT D.O.	13.3	9.1
NH3-N UP, PLANT NH3-N	0	3.6
ULTIMATE BOD UP, PLANT BOD=	4.1	22.2

****

UPSTREAM FLOW (CFS)	204
PLANT FLOW (CFS)	10.2
DOWNSTREAM FLOW (CFS)	214.2
DILUTION RATIO	20
MIXED ULT. BOD (MG/L)	4.96
MIXED ULT. NOD (MG/L)	.74
MIXED TEMPERATURE (C)	2.69
MIXED D.O. (MG/L)	13.1
D.O. 100% SAT =	13.59
K1=	.04
K2=	3.57
K3=	9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	13.1	.49
5.2	0	13.08	.51
5	.01	13.06	.53
4.8	.01	13.05	.55
4.6	.01	13.03	.56
4.4	.02	13.02	.58
4.2	.02	13	.59
4	.02	12.99	.6
3.8	.03	12.98	.62
3.6	.03	12.97	.63
3.4	.03	12.96	.64
3.2	.04	12.94	.65
3	.04	12.94	.66
2.8	.04	12.93	.67
2.6	.05	12.92	.67
2.4	.05	12.91	.68
2.2	.05	12.9	.69
2	.06	12.9	.7
1.8	.06	12.89	.7
1.6	.06	12.89	.71
1.4	.07	12.88	.71
1.2	.07	12.88	.72
1	.07	12.87	.72
.8	.08	12.87	.73
.6	.08	12.86	.73
.4	.08	12.86	.73
.2	.09	12.86	.73
0	.09	12.86	.74

APPENDIX V

October stream conditions under Table 5 effluent limitation of 0.1 mg/L NH_3-N.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5 MG/L

*********************** INPUT ECHO ***********************

PLANT FLOW (CFS)	14	
TEMP UP,PLANT TEMP	10.9	16.2
D.O. UP,PLANT D.O.	12	7.2
NH3-N UP, PLANT NH3-N	0	.1
FIVE DAY BOD UP, PLANT BOD=	2	30

****

UPSTREAM FLOW (CFS)	.1
PLANT FLOW (CFS)	14
DOWNSTREAM FLOW (CFS)	14.1
DILUTION RATIO	.01
MIXED ULT. BOD (MG/L)	94.83
MIXED ULT. NOD (MG/L)	.43
MIXED TEMPERATURE (C)	16.16
MIXED D.O. (MG/L)	7.23
D.O. 100% SAT =	9.91
K1=	.08
K2=	2.56
K3=	9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	7.23	2.67
5.2	.01	7.19	2.72
5	.02	7.15	2.76
4.8	.03	7.11	2.8
4.6	.04	7.08	2.83
4.4	.06	7.05	2.85
4.2	.07	7.03	2.88
4	.08	7.01	2.9
3.8	.09	6.99	2.91
3.6	.1	6.98	2.93
3.4	.11	6.97	2.94
3.2	.12	6.96	2.95
3	.13	6.95	2.96
2.8	.14	6.94	2.96
2.6	.16	6.94	2.97
2.4	.17	6.93	2.97
2.2	.18	6.93	2.98
2	.19	6.93	2.98
1.8	.2	6.93	2.98
1.6	.21	6.93	2.98
1.4	.22	6.93	2.98
1.2	.23	6.93	2.97
1	.24	6.93	2.97
.8	.26	6.94	2.97
.6	.27	6.94	2.97
.4	.28	6.94	2.96
.2	.29	6.95	2.96
0	.3	6.95	2.96

NO DISSOLVED OXYGEN CRITERION VIOLATIONS OCCUR WITHIN RANGE

October stream conditions under observed effluent NH_3-N concentration of 3.6 mg/L.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5 MG/L

************************ INPUT ECHO ************************

PLANT FLOW (CFS)	14	
TEMP UP,PLANT TEMP	10.9	16.2
D.O. UP,PLANT D.O.	12	7.2
NH3-N UP, PLANT NH3-N	0	3.6
FIVE DAY BOD UP, PLANT BOD=	2	30

****

UPSTREAM FLOW (CFS)	.1
PLANT FLOW (CFS)	14
DOWNSTREAM FLOW (CFS)	14.1
DILUTION RATIO	.01
MIXED ULT. BOD (MG/L)	94.83
MIXED ULT. NOD (MG/L)	15.48
MIXED TEMPERATURE (C)	16.16
MIXED D.O. (MG/L)	7.23
D.O. 100% SAT =	9.91
K1=	.08
K2=	2.56
K3=	9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	7.23	2.67
5.2	.01	5.66	4.25
5	.02	4.28	5.62
4.8	.03	3.1	6.81
4.6	.04	2.07	7.83
4.4	.06	1.2	8.71
4.2	.07	.45	9.46
4	.08	-.18	10.09
3.8	.09	-.71	10.62
3.6	.1	-1.15	11.06
3.4	.11	-1.51	11.42
3.2	.12	-1.8	11.7
3	.13	-2.02	11.93
2.8	.14	-2.19	12.1
2.6	.16	-2.31	12.22
2.4	.17	-2.39	12.29
2.2	.18	-2.43	12.33
2	.19	-2.43	12.34
1.8	.2	-2.41	12.32
1.6	.21	-2.36	12.27
1.4	.22	-2.29	12.2
1.2	.23	-2.21	12.11
1	.24	-2.1	12.01
.8	.26	-1.99	11.89
.6	.27	-1.86	11.77
.4	.28	-1.72	11.63
.2	.29	-1.57	11.48
0	.3	-1.42	11.33

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 15 CFS

November stream conditions under Table 5 effluent limitation of 0.5 mg/L NH_3-N.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5.22 MG/L

************************ INPUT ECHO ************************

PLANT FLOW (CFS)	14	
TEMP UP,PLANT TEMP	6.8	14.2
D.O. UP,PLANT D.O.	12.4	7.4
NH3-N UP, PLANT NH3-N	0	.5
FIVE DAY BOD UP, PLANT BOD=	2	30

****

UPSTREAM FLOW (CFS)	1
PLANT FLOW (CFS)	14
DOWNSTREAM FLOW (CFS)	15
DILUTION RATIO	.07
MIXED ULT. BOD (MG/L)	98.33
MIXED ULT. NOD (MG/L)	2.02
MIXED TEMPERATURE (C)	13.71
MIXED D.O. (MG/L)	7.73
D.O. 100% SAT =	10.43
K1=	.07
K2=	2.45
K3=	9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	7.73	2.7
5.2	.01	7.53	2.9
5	.02	7.35	3.08
4.8	.03	7.2	3.24
4.6	.04	7.06	3.37
4.4	.06	6.95	3.48
4.2	.07	6.85	3.58
4	.08	6.77	3.67
3.8	.09	6.7	3.74
3.6	.1	6.64	3.79
3.4	.11	6.59	3.84
3.2	.12	6.55	3.88
3	.13	6.52	3.91
2.8	.14	6.5	3.93
2.6	.15	6.48	3.95
2.4	.17	6.47	3.96
2.2	.18	6.47	3.97
2	.19	6.46	3.97
1.8	.2	6.47	3.97
1.6	.21	6.47	3.96
1.4	.22	6.48	3.95
1.2	.23	6.49	3.94
1	.24	6.5	3.93
.8	.25	6.52	3.91
.6	.26	6.54	3.9
.4	.28	6.55	3.88
.2	.29	6.57	3.86
0	.3	6.59	3.84

NO DISSOLVED OXYGEN CRITERION VIOLATIONS OCCUR WITHIN RANGE

November stream conditions under observed effluent NH_3-N concentration of 3.6 mg/L.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5.22 MG/L

************************ INPUT ECHO ************************

PLANT FLOW (CFS)	14	
TEMP UP,PLANT TEMP	6.8	14.2
D.O. UP,PLANT D.O.	12.4	7.4
NH3-N UP, PLANT NH3-N	0	3.6
FIVE DAY BOD UP, PLANT BOD=	2	30

****

UPSTREAM FLOW (CFS)	1
PLANT FLOW (CFS)	14
DOWNSTREAM FLOW (CFS)	15
DILUTION RATIO	.07
MIXED ULT. BOD (MG/L)	98.33
MIXED ULT. NOD (MG/L)	14.55
MIXED TEMPERATURE (C)	13.71
MIXED D.O. (MG/L)	7.73
D.O. 100% SAT =	10.43
K1=	.07
K2=	2.45
K3=	9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	7.73	2.7
5.2	.01	6.26	4.17
5	.02	4.98	5.45
4.8	.03	3.87	6.56
4.6	.04	2.91	7.52
4.4	.06	2.08	8.35
4.2	.07	1.38	9.06
4	.08	.78	9.66
3.8	.09	.27	10.16
3.6	.1	-.15	10.58
3.4	.11	-.49	10.93
3.2	.12	-.77	11.21
3	.13	-.99	11.43
2.8	.14	-1.16	11.6
2.6	.15	-1.29	11.72
2.4	.17	-1.37	11.8
2.2	.18	-1.42	11.85
2	.19	-1.43	11.87
1.8	.2	-1.42	11.86
1.6	.21	-1.39	11.82
1.4	.22	-1.33	11.77
1.2	.23	-1.26	11.69
1	.24	-1.17	11.6
.8	.25	-1.07	11.5
.6	.26	-.96	11.39
.4	.28	-.83	11.27
.2	.29	-.7	11.14
0	.3	-.57	11

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 14 CFS

December stream conditions under Table 5 effluent limitation of 3.0 mg/L NH_3-N.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5.8 MG/L

************************ INPUT ECHO ************************

PLANT FLOW (CFS)	14	
TEMP UP,PLANT TEMP	5.8	13.3
D.O. UP,PLANT D.O.	12.4	8.1
NH3-N UP, PLANT NH3-N	0	3
FIVE DAY BOD UP, PLANT BOD=	2	30

****

UPSTREAM FLOW (CFS)	19.1
PLANT FLOW (CFS)	14
DOWNSTREAM FLOW (CFS)	33.1
DILUTION RATIO	1.36
MIXED ULT. BOD (MG/L)	58.28
MIXED ULT. NOD (MG/L)	5.49
MIXED TEMPERATURE (C)	8.97
MIXED D.O. (MG/L)	10.58
D.O. 100% SAT =	11.61
K1=	.05
K2=	2.57
K3=	9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	10.58	1.03
5.2	.01	10.09	1.51
5	.02	9.66	1.94
4.8	.03	9.28	2.33
4.6	.04	8.94	2.66
4.4	.05	8.64	2.96
4.2	.06	8.38	3.22
4	.07	8.16	3.45
3.8	.08	7.96	3.65
3.6	.09	7.79	3.82
3.4	.09	7.64	3.97
3.2	.1	7.52	4.09
3	.11	7.41	4.19
2.8	.12	7.33	4.28
2.6	.13	7.25	4.35
2.4	.14	7.2	4.41
2.2	.15	7.16	4.45
2	.16	7.13	4.48
1.8	.17	7.1	4.5
1.6	.18	7.09	4.51
1.4	.19	7.09	4.52
1.2	.2	7.09	4.51
1	.21	7.1	4.5
.8	.22	7.12	4.48
.6	.23	7.14	4.46
.4	.24	7.17	4.44
.2	.25	7.2	4.41
0	.26	7.23	4.37

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 12 CFS

December stream conditions under observed effluent NH_3-N concentration of 3.6 mg/L.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5.8 MG/L

*********************** INPUT ECHO ***********************

PLANT FLOW (CFS)	14	
TEMP UP,PLANT TEMP	5.8	13.3
D.O. UP,PLANT D.O.	12.4	8.1
NH3-N UP, PLANT NH3-N	0	3.6
FIVE DAY BOD UP, PLANT BOD=	2	30

****

UPSTREAM FLOW (CFS)	19.1
PLANT FLOW (CFS)	14
DOWNSTREAM FLOW (CFS)	33.1
DILUTION RATIO	1.36
MIXED ULT. BOD (MG/L)	58.28
MIXED ULT. NOD (MG/L)	6.59
MIXED TEMPERATURE (C)	8.97
MIXED D.O. (MG/L)	10.58
D.O. 100% SAT =	11.61
K1=	.05
K2=	2.57
K3=	9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	10.58	1.03
5.2	.01	10	1.61
5	.02	9.48	2.13
4.8	.03	9.02	2.58
4.6	.04	8.62	2.99
4.4	.05	8.26	3.35
4.2	.06	7.95	3.66
4	.07	7.68	3.93
3.8	.08	7.44	4.17
3.6	.09	7.24	4.37
3.4	.09	7.06	4.55
3.2	.1	6.91	4.69
3	.11	6.79	4.82
2.8	.12	6.68	4.92
2.6	.13	6.6	5
2.4	.14	6.53	5.07
2.2	.15	6.48	5.12
2	.16	6.45	5.16
1.8	.17	6.42	5.18
1.6	.18	6.41	5.2
1.4	.19	6.41	5.2
1.2	.2	6.41	5.19
1	.21	6.43	5.18
.8	.22	6.45	5.16
.6	.23	6.47	5.13
.4	.24	6.51	5.1
.2	.25	6.54	5.06
0	.26	6.58	5.02

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 16 CFS

January stream conditions under Table 5 effluent limitation of 16.5 mg/L NH_3-N.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 6.49 MG/L

*********************** INPUT ECHO ***********************

PLANT FLOW (CFS)	14	
TEMP UP,PLANT TEMP	2.3	13.3
D.O. UP,PLANT D.O.	13.2	7.8
NH3-N UP, PLANT NH3-N	0	16.5
FIVE DAY BOD UP, PLANT BOD=	2	30

****

UPSTREAM FLOW (CFS)	57.7
PLANT FLOW (CFS)	14
DOWNSTREAM FLOW (CFS)	71.7
DILUTION RATIO	4.12
MIXED ULT. BOD (MG/L)	37.77
MIXED ULT. NOD (MG/L)	13.95
MIXED TEMPERATURE (C)	4.45
MIXED D.O. (MG/L)	12.15
D.O. 100% SAT =	12.98
K1=	.04
K2=	3.03
K3=	9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	12.14	.83
5.2	.01	11.2	1.78
5	.01	10.34	2.64
4.8	.02	9.56	3.42
4.6	.03	8.85	4.13
4.4	.04	8.21	4.76
4.2	.04	7.64	5.34
4	.05	7.12	5.85
3.8	.06	6.66	6.31
3.6	.07	6.25	6.73
3.4	.07	5.89	7.09
3.2	.08	5.56	7.42
3	.09	5.28	7.7
2.8	.09	5.03	7.95
2.6	.1	4.82	8.16
2.4	.11	4.63	8.34
2.2	.12	4.48	8.5
2	.12	4.35	8.63
1.8	.13	4.24	8.74
1.6	.14	4.16	8.82
1.4	.15	4.09	8.88
1.2	.15	4.05	8.93
1	.16	4.02	8.96
.8	.17	4	8.97
.6	.17	4	8.97
.4	.18	4.02	8.96
.2	.19	4.04	8.94
0	.2	4.08	8.9

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 80 CFS

February stream conditions under Table 5 effluent limitation of 10.4 mg/L NH_3-N.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 6.23 MG/L

************************ INPUT ECHO ************************

PLANT FLOW (CFS)	14	
TEMP UP,PLANT TEMP	4.6	11.1
D.O. UP,PLANT D.O.	13.6	8.4
NH3-N UP, PLANT NH3-N	0	10.4
FIVE DAY BOD UP, PLANT BOD=	2	30

****

UPSTREAM FLOW (CFS)	49.4
PLANT FLOW (CFS)	14
DOWNSTREAM FLOW (CFS)	63.4
DILUTION RATIO	3.53
MIXED ULT. BOD (MG/L)	38.79
MIXED ULT. NOD (MG/L)	9.94
MIXED TEMPERATURE (C)	6.04
MIXED D.O. (MG/L)	12.45
D.O. 100% SAT =	12.46
K1=	.05
K2=	2.98
K3=	9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	12.45	.01
5.2	.01	11.73	.74
5	.02	11.07	1.4
4.8	.02	10.47	1.99
4.6	.03	9.93	2.53
4.4	.04	9.45	3.02
4.2	.05	9.01	3.45
4	.05	8.62	3.84
3.8	.06	8.28	4.19
3.6	.07	7.97	4.5
3.4	.08	7.69	4.77
3.2	.08	7.45	5.01
3	.09	7.24	5.23
2.8	.1	7.05	5.41
2.6	.11	6.89	5.57
2.4	.12	6.76	5.71
2.2	.12	6.64	5.82
2	.13	6.54	5.92
1.8	.14	6.47	6
1.6	.15	6.4	6.06
1.4	.15	6.36	6.11
1.2	.16	6.32	6.14
1	.17	6.3	6.16
.8	.18	6.29	6.17
.6	.18	6.29	6.18
.4	.19	6.3	6.17
.2	.2	6.31	6.15
0	.21	6.34	6.13

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 48 CFS

March stream conditions under Table 5 effluent limitation of 12.8 mg/L NH_3-N.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 6.08 MG/L

********************* INPUT ECHO *********************

PLANT FLOW (CFS)	14	
TEMP UP,PLANT TEMP	5.9	12.8
D.O. UP,PLANT D.O.	12.6	7.8
NH3-N UP, PLANT NH3-N	0	12.8
FIVE DAY BOD UP, PLANT BOD=	2	30

****

UPSTREAM FLOW (CFS)	72.4
PLANT FLOW (CFS)	14
DOWNSTREAM FLOW (CFS)	86.4
DILUTION RATIO	5.17
MIXED ULT. BOD (MG/L)	29.77
MIXED ULT. NOD (MG/L)	8.98
MIXED TEMPERATURE (C)	7.02
MIXED D.O. (MG/L)	11.82
D.O. 100% SAT =	12.16
K1=	.05
K2=	3.48
K3=	9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	11.82	.34
5.2	.01	11.26	.91
5	.01	10.74	1.43
4.8	.02	10.26	1.9
4.6	.03	9.83	2.33
4.4	.03	9.44	2.72
4.2	.04	9.09	3.07
4	.05	8.77	3.39
3.8	.05	8.48	3.68
3.6	.06	8.22	3.94
3.4	.07	7.99	4.17
3.2	.07	7.79	4.38
3	.08	7.6	4.56
2.8	.09	7.44	4.72
2.6	.09	7.3	4.86
2.4	.1	7.18	4.99
2.2	.11	7.07	5.09
2	.11	6.98	5.18
1.8	.12	6.91	5.26
1.6	.13	6.85	5.32
1.4	.13	6.8	5.37
1.2	.14	6.76	5.4
1	.15	6.73	5.43
.8	.15	6.72	5.45
.6	.16	6.71	5.46
.4	.17	6.71	5.46
.2	.17	6.71	5.45
0	.18	6.73	5.44

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 64 CFS

April stream conditions under Table 5 effluent limitation of 6.5 mg/L NH_3-N.

MILL CREEK D.O. MODEL
INSTREAM D.O. CRITERION 5.95 MG/L

********************** INPUT ECHO **********************

PLANT FLOW (CFS)	14	
TEMP UP,PLANT TEMP	6.2	14.2
D.O. UP,PLANT D.O.	13.1	7.4
NH3-N UP, PLANT NH3-N	0	6.5
FIVE DAY BOD UP, PLANT BOD=	2	30

****

UPSTREAM FLOW (CFS)	55.1
PLANT FLOW (CFS)	14
DOWNSTREAM FLOW (CFS)	69.1
DILUTION RATIO	3.94
MIXED ULT. BOD (MG/L)	33.83
MIXED ULT. NOD (MG/L)	5.7
MIXED TEMPERATURE (C)	7.82
MIXED D.O. (MG/L)	11.95
D.O. 100% SAT =	11.93
K1=	.05
K2=	3.21
K3=	9.82

RIVER MILE	DAYS	D.O.	DEFICIT
5.4	0	11.94	-.02
5.2	.01	11.54	.39
5	.01	11.17	.76
4.8	.02	10.83	1.1
4.6	.03	10.53	1.4
4.4	.04	10.25	1.68
4.2	.04	10	1.93
4	.05	9.78	2.15
3.8	.06	9.58	2.35
3.6	.07	9.4	2.53
3.4	.07	9.24	2.69
3.2	.08	9.1	2.83
3	.09	8.98	2.95
2.8	.1	8.87	3.06
2.6	.1	8.77	3.15
2.4	.11	8.69	3.24
2.2	.12	8.62	3.31
2	.13	8.56	3.36
1.8	.13	8.52	3.41
1.6	.14	8.48	3.45
1.4	.15	8.45	3.48
1.2	.16	8.42	3.51
1	.16	8.41	3.52
.8	.17	8.4	3.53
.6	.18	8.39	3.54
.4	.19	8.39	3.54
.2	.19	8.4	3.53
0	.2	8.41	3.52

MINIMUM UPSTREAM FLOW UNDER SPECIFIED CONDITIONS IS 31 CFS